DOPPLER STUDY IN GESTATIONAL HYPERTENSION AND FETAL OUTCOME

DISSERTATION SUBMITTED FOR

BRANCH II M.D.

(OBSTETRICS & GYNAECOLOGY) EXAMINATIONS

SEPTEMBER 2006

MADURAI MEDICAL COLLEGE, MADURAI

THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY

CHENNAI

CERTIFICATE

This is to certify that the dissertation entitled ***Doppler Study in Gestational Hypertension and Fetal Outcome"*** *submitted by* ***Dr. A. Geetha*** *to the Faculty of Obstetrics and Gynaecology, The Tamilnadu Dr. M.G.R. Medical university, Chennai in partial fulfillment of the requirement for the award of M.D. Degree Branch II (Obstetrics and Gynaecology) is a bonafide research work carried out by her during the period of January 2005 to February 2006 under our direct supervision and guidance.*

Dean,
Govt. Rajaji Hospital,
Madurai Medical College,
Madurai

Professor and Head
Dept., of Obst. and Gynaecology
Govt. Rajaji Hospital,
Madurai Medical College,
Madurai.

ACKNOWLEDGEMENTS

I thank the **Dean,** Madurai Medical College for granting me permission to undertake this clinical study in Goverment Rajaji Hospital, Madurai.

I sincerely thank our beloved Professor, Head of the Department, Department of Obstetrics and Gynaecology, **Dr. Suthandira Devi M.D., D.G.O.,** for her able guidance, encouragement and immense help provided to complete the study.

I express my sincere thanks to **Dr. Raja Rajeswari** MD., D.G.O. for her valuable suggestions regarding this study.

I am grateful to **Prof. Dr. Revathy Janakiram** M.D., D.G.O.,M.N.A.M.S., for her guidance and help in doing this study.

*I am extremely thankful to **Dr. Gowri M.D.,D.G.O.,** Former Head of the Department, Department of Obstetrics and Gynaecology, Madurai Medical College, Madurai for her constant and sound advice to complete this study.*

I am thankful to the Head of the Department, Department of Radiology and **Dr. Sumathy M.D., D.M.R.D.**, Dept of Radiology, Government Rajaji Hospital, Madurai for their able guidance.

My sincere thanks goes to **Dr. Raghavan M.D., D.M.R.D., Sonoscans** for his able guidance and invaluable help to complete this study.

Also I thank **Dr. Manoharan M.D., D.M.R.D.**, **Doppler Scans**, Madurai for his able guidance. And I thank all **my patients** for having subjected themselves for this study and for their cooperation.

CONTENTS

INTRODUCTION

INTRODUCTION

Doppler study in Gestational Hypertension and preeclampsia

Quality of life for both mother and the newborn has now rightly become our top priority in the field of obstetrics. It is apparent that no greater services can be provided, than ensuring that each new born is well born.

Hypertensive disorders complicating pregnancy are common and form one of the deadly triad, along with haemorrhage and infection that contribute greatly to maternal morbidity and mortality.

According to National Centre for Health Statistics, gestational hypertension was identified in 3.7 % of pregnancies. A research is sponsored by the National Institute of Child Health and Human Development (NICHD) and its Maternal – Fetal Medicine Unit Network is going on now.

The term Gestational Hypertension was adopted by the working group of the NHBPEP. Gestational Hypertension is a common medical disorder of pregnancy occurring approximately in 70% of primi gravidas.

Gestational Hypertension is defined as Blood pressure ≥ 140/90 mmHg for the first time during pregnancy with no proteinuria, and BP returns

to normal within 12 weeks postpartum. So the final diagnosis is made only postpartum. It may have other signs and symptoms of preeclampsia.

Preeclampsia

This condition is best described as a pregnancy specific syndrome of reduced organ perfusion secondary to vasospasm and endothelial activation. Proteinuria is an important sign of pre eclampsia.

Doppler sonography is one of the most important clinical tools for fetal surveillance of Hypertensive pregnancies.

An increase in the Doppler indices in uterine and umbilical vessels may indicate impairment of the placental circulation. Information regarding organ's blood flow may allow better management of the mother and fetus at risk.

The efficacy of Doppler ultrasonography in severe PIH and preeclampsia, in relation to adverse perinatal outcome, rate of caesarean section and further management are critically evaluated in this study

AIM OF THE STUDY

AIM OF THE STUDY

1. To study the variation in the uterine and umbilical artery blood flow pattern in Gestational Hypertension and preeclampsia.

2. To evaluate the efficacy of Doppler velocimetry in early diagnosis of fetal hypoxia and to decide about the mode of termination in gestational hypertension and preeclampsia.

3. To correlate the Doppler study with fetal outcome and critical analysis of the association of abnormal Doppler velocimetry in perinatal outcome.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Depending upon the country, the various Hypertensive disorders constitute 5 –10% of pregnancies. The word eclampsia dates from the 17th century. It is derived from a Greek word meaning 'to shine forth' because of the visual phenomena accompanying the condition. The associated seizures were believed to be due to blood poisoning (or) toxins derived from pregnancy – Hence the term toxemia of pregnancy.

Alexander Hamiliton – (1781) described Eclampsia as a condition associated with seizures. Bright in 1827, recognized albuminuria in addition relating to Eclampsia.

Later with the advancement of science, the emphasis was laid more on genetic, haematological, biochemical hormonal and immunological explanations.

Chesly et al have concluded that preeclampsia could be due to simple recessive trait.

Doppler velocimetry in Preeclampsia

Fleischer et al in 1986 studied the correlations of severity of preeclampsia with pregnancy outcome, He concluded that when the

uterine artery systolic - diastolic ratio was more than 2.6 during the III trimester, incidence of fetal distress during delivery is high. According to him, about 67% of hypertensive patients with abnormal umbilical blood flow deliver growth retarded babies.

Thaler et al in 1992 reported that an increased uterine artery RI without a notch poorly correlates with adverse fetal outcome. He concluded that hypertensive pregnant women were divided into four groups based on the presence or absence of a uterine notch or Umbilical artery RI .

The presence of both was associated with most severe complications. In his study, perinatal mortality was 21% and 74% of fetuses were growth retarded.

Abnormal umbilical artery Doppler velocimetry characterised by absent or reverse end diastolic flow signifying increased impedence has been uniquely associated with fetal growth restriction. (ACOG 2000)

Among the several parameters employed to evaluate the changes in velocity waveforms, the simplest and the most commonly employed is the S/D ratio. Flecischer et al 1989. Rajan 1991.

Tyrell S, Opaid AH, Lilford RJ- 1989- studied – umbilical artery Doppler velocimetry as a predictor of fetal hypoxia and acidosis at birth. Obstet – Gynecol 14 : 332-337. He observed a significant association between the absence of end diastolic flow in umbilical artery and hypoxia and acidosis.

Schulman H in 1987 – the clinical implications of Doppler ultrasound analysis of the uterine and umbilical arteries. – Am. J. Obstet Gynecol 156 : 889-893.

Rochelson B Schulman H. Farma Kides G, et al (1987) said about the significance of absent end diastolic velocity in umbilical artery velocity waveforms. Am. J. Obstet – Gynecol 156 : 1213-1218.

Fairle FM. Morette, M. Walker JJ Sibai BM (1991) determinants of perinatal outcome in gestational hypertension with absence of umbilical artery end diastolic frequencies. Am. J. Obstet. Gynecol 164 : 1084-1089.

Abnormal umbilical artery Doppler velocity characterised by absent or reversed end diastolic flow signifying increased impedence has been uniquely associated with fetal growth restriction (ACOG – 2000).

GESTATIONAL HYPERTENSION /

PREECLAMPSIA

GESTATIONAL HYPERTENSION / PREECLAMPSIA

Definition

The term Gestational hypertension was adopted by working group of the NHBPEP (2000).

The diagnosis of Gestational hypertension is made in women whose blood pressure reaches140/90 mmHg or greater for the first time during pregnancy after 20 weeks and in whom proteinuria is not identified.

It is called transient hypertension if the proteinuria has not developed and the BP returns to normal by 12 weeks post partum.

Preeclampsia

This condition is described as a pregnancy specific syndrome of reduced organ perfusion secondary to vasospasm and endothelial activation. Proteinuria is an important sign – 300mg/24hrs – or persistent 30mg/dl in random urine samples.

Minimum Criteria

BP	≥	140 mmHg after 20 weeks of gestation 90
Proteinuria	≥	300 mg/24 hrs

Increased Certainty of pre eclampsia

- BP > 160 mmHG / 110
- Proteinuria 2.0 gm/24 hours
- Serum creatinine > 1.2 mg/dl
- Platelets < 100,000/mm^3
- Microangiopathic hemolysis
- Persistent headache, visual disturbance or epigastric pain

Eclampsia

Seizures that cannot be attributed to other causes in a women with preeclampsia

1. Superimposed preeclampsia:

★ New onset proteinuria 300mg/ 24hrs in a hypertensive women but no proteinuria before 20 weeks.

(or)

★ A sudden increase in proteinuria (or) Bp (or) platelet court < 100,00/mm^3 in women with hypertension and proteinuria before 20 weeks.

2. Chronic hypertension

★ Bp $\geq$ 140/90 before pregnancy (or) diagnosed before 20 weeks not attributable to gestational trophoblastic disease

(or)

★ Hypertension first diagnosed after 20 weeks gestation and persistent after 12 weeks post partum.

Incidence

1. The incidence of preeclampsia is about 5%
2. In USA, the incidence of Eclampsia is 1 in 3250 1998.
3. In the United Kingdom in 1992, Douglas and Redman (1994) reported that the incidence of Eclampsia was 1 in 2000.

Risk Factors

1. Nulliparous women.
2. Chronic hypertension and Diabetics women at either end of reproductive age.
3. Genetic predisposition
4. Environmental factors.
5. Living at High altitude.
6. Obesity.
7. Twin gestations.

Etiology

Preeclampsia is more likely to develop in women who

1. Are exposed to chorionic villi for the first time.
2. Are exposed to super abundance of chorionic villi as with twins (or) hydatiform mole.

3. Have preexisting vascular disease are genetically predisposed to hypertension developing during pregnancy.

A fetus is not a requisite for pre eclampsia. According to SIBAI (2003) currently plausible potential causes include.

1. Abnormal trophoblastic invasion of uterine vessels.
2. Immunological intolerance between maternal and fetoplacental tissues
3. Maternal Maladaptations to cardiovascular (or) inflammatory changes of normal pregnancy.
4. Dietary deficiencies
5. Genetic influences

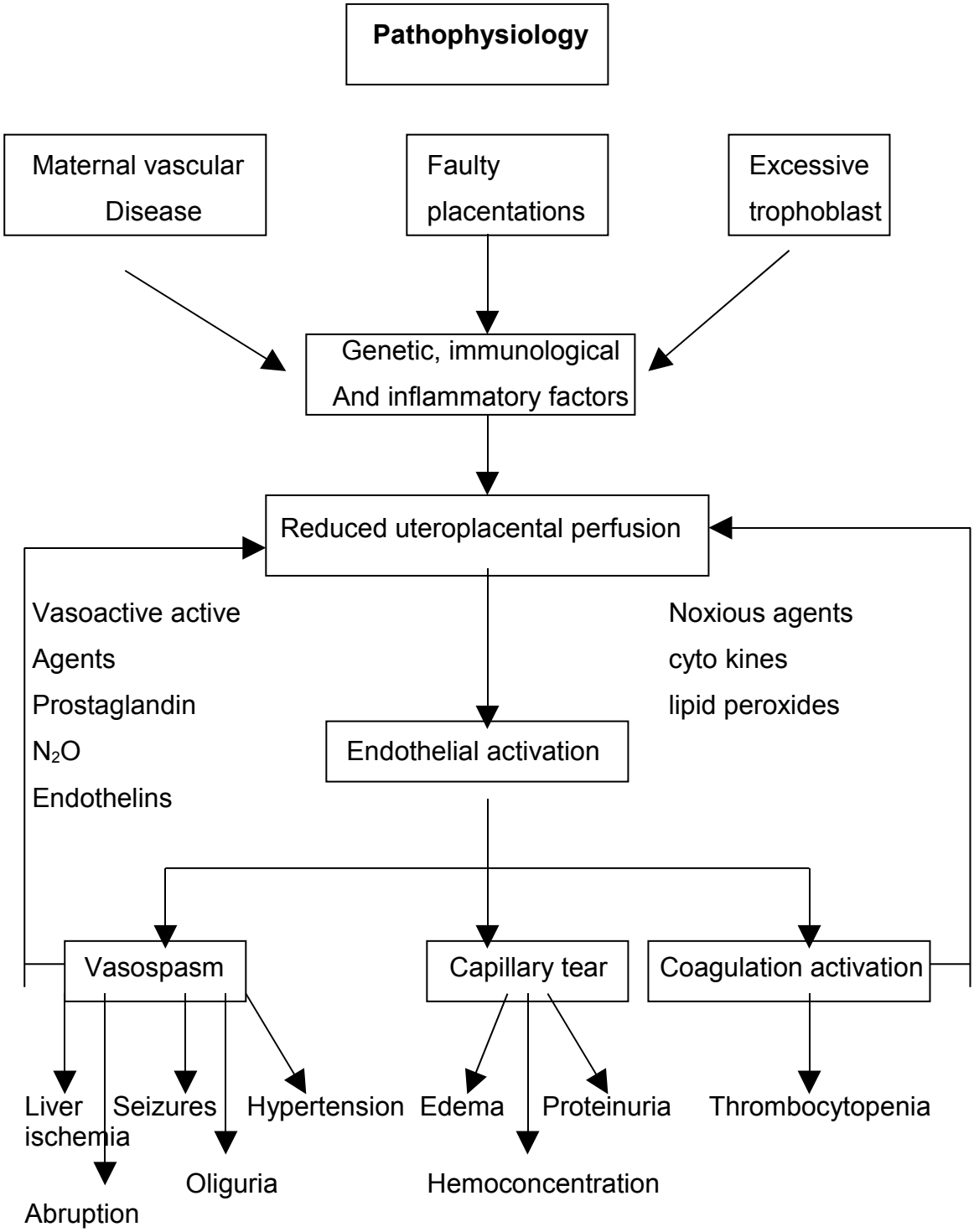
Nutritional Factors

1 Dietary deficiencies like zinc, calcium and magnesium.

2 Obesity predispose to preeclampsia.

Genetic Factors

- ★ The tendency for preeclampsia and eclampsia is inherited.
- ★ A Swedish study by Nilsson and co workers reported 60% concordance in monozygotic female twins.
- ★ Kilpatrie and associates reported an association between HLA-DR4 and proteinuric hypertension.



Pathophysiology

Severe disturbance of normal cardio vascular functions are common with preeclampsia. They are also

1. Increased cardiac after Load caused by hypertension.
2. Cardiac preload – affected by pathologically diminished hypervolemia of pregnancy.
3. Endothelial cell activations with extravasation into the extracellular space ⟶ Lung

Hemo concentration is the hall mark of Preeclampsia. With eclampsia, however, much or all of anticipated excess 1500 ml of blood normally present is absent. This hemo concentration is the consequence of generalised vaso constriction and endothelial dysfunction.

Blood and Coagulation

Among the haematological abnormalities, thrombocytopenia may become so severe as to be life threatening. In addition levels of some clotting factors may be decreased and erythrocytes may display bizarre shapes and undergo rapid hemolysis.

Overt thrombocytopenia defined as platelet count lesser than 100,000/μL indicates severe disease. In most cases delivery is indicated. Thrombocytopenia results from platelet activation, aggregation and consumption that is accompanied by increased mean platelet volume and decreased life span.

Hellp Syndrome

P Ritchard and Colleagues called attention to thrombocytopenia, elevated liver enzymes and hemolysis. Weinstein in 1982 later referred this combination of events as the HELLP syndrome.

Fragmentation Hemolysis

Severe preeclampsia is frequently accompanied by evidence of hemolysis indicated by elevated LDH enzyme.

Other changes from peripheral blood includes Schizocytosis, Spherocytosis and Reticulocytosis. These changes result from Microangiopathic hemolysis caused by endothelial disruption with platelet adherence and fibrin deposition.

Kidney

In the kidney, renal perfusion and glomerular filtration are reduced. This results in increase in plasma creatinine value up to twice the normal. There occurs intrarenal vasospasm resulting in plasma creatinine up to 3 – 4 mg/dl and severe oliguria.

Meyer and colleagues recommended 24 hours measurements. Electron microscopy studies of renal biopsy are consistent with glomerular capillary endotheliosis. Acute renal failure from acute tubular necrosis and rarely irreversible renal cortical necrosis may develop.

Liver

Hepatic changes in women with fatal eclampsia were described by Virchow. The characteristic lesion is periportal haemorrhage and subcapsular haematoma.

Uteroplacental vascular pathology

Changes in the uteroplacental vessels particularly in the spiral arteries hold key to pathophysiology of PIH.

Failure of Second wave of Trophoblastic Invasion

In early normal pregnancy at 8 weeks, cytotrophoblastic cells, proliferate and invade the endothelium of the maternal spiral arterioles, destroy elastic and muscular tissue, which is replaced by fibrinoid material.

Between 12 to 16 weeks there is a further wave of cytotrophoblastic invasion into the stroma of the myometrium portion of the spiral arterioles and further opens up the arteries to produce increase in choriodecidual blood flow.

On the basis of placental bed biopsies by Dixon and Robertson (1961) Brosens et al (1972) and Robertson (1976) reported that in preeclampsia, there is failure in the second wave of trophoblastic invasions. Musculo elastic media of the spiral arteries are retained and the vessels fails to dilate and remains responsive to vasopressor agents.

Acute Atherosis

In some spiral arteries there is an accumulation of lipid in the muscle cells of media and interna leading to necrosis, which is then taken up by macrophages to produce lesions which appear like atheroma, hence the name acute atherosis. It is associated with thrombosis, vascular occlusions and placental infarction. Acute atherosis is not found in uncomplicated essential hypertension.

Peripheral vascular resistance, uterine vascular resistance and distributions of blood flow

The total peripheral resistance (TPR) is determined by the total of the resistance to blood flow of all the organs and tissues of the body.

$$\text{Total peripheral resistance} = \frac{\text{Mean arterial pressure}}{\text{Cardiac output}}$$

Resistance to blood flow is primarily arteriolar and is dependent on the cross sectional area, length of the vessels and viscosity of the blood.

In hypertension in pregnancy TPR is increased. More important than TPR is the balance of vascular resistance between different organs of the body, particularly between uterus and the rest of the body.

$$\text{Uterine blood flow} = \frac{\text{uterine perfusion pressure}}{\text{Uterine vascular resistance}}$$

Assuming that uterine perfusion pressure is the same as that of arterial Bp, equations can be restated as

$$\text{Uterine blood flow} = \frac{\text{Cardiac output}}{\text{Uterine vascular resistance}} \times \text{TPR}$$

This means that the uterine blood flow is determined not so much by the BP so as by the ratio of the uterine vascular resistance to the TPR.

The main aim of treatment of hypertension in pregnancy is to increase uterine blood flow by preferential vasodilatation of the uterine vessels.

Uteroplacental perfusion estimation

Compromised uteroplacental perfusions due to vasospasm is the main culprit.

Indirect measurement of uteroplacental blood flow

1. The clearance rate of dehydroisoandrosterone SO_4 through placental conversion to 17 β estradiol reflects placental perfusion.

2. Doppler Velocimetry - Ducey in 1987, Fleischer 1980 and all their colleagues described vascular resistance can be estimated by comparing arterial systolic and diastolic velocity wave forms

Doppler Ultrasonogram

Doppler Ultrasonogram

Doppler Ultrasound is a new non invasive technique that we have used in this study to determine the qualitative aspects of uteroplacental and fetal circulation.

Fetus is relatively inaccessible to any form of antenatal well being studies. It may be prudent to consider delivery of the fetus, once presumptive evidence of hypoxia is demonstrated. This is best accomplished with Doppler studies which can reliably predict adverse perinatal outcome in pregnancy induced Hypertension.

History of Doppler

- ★ In 1943, an Austrian physicist, Joharis Christian Doppler was the first to describe the phenomena of Doppler effect, which is the basic Principle of Doppler effect.
- ★ In 1957 Satomura used it to investigate human circulation.
- ★ In 1977 Fitzgerald and Drumm described first the application of Doppler USG in obstetrics.
- ★ In 1989, Trudinger and Gilis described the fall in S/D Ratio from 24 weeks to term, confirming the downstream impedance in the placental vascular system.

Doppler shift

The Doppler shift is a physical principle that states that when a source of light (or) sound waves is moving relative to an observer, the observer detects a shift in the wave frequency. Here the sound source is the ultra sound transducer; the moving target is the red blood cells flowing through the circulation.

Doppler shift is submitted to spectrographic analysis and represented graphically as waveforms. Analysis of wave forms provides qualitative measurement of resistance to flow in vessels.

Doppler Equation

The equation is used to estimate the velocity of red cells and derivatives from that factor. The equation is

$$fd = 2\, fo \frac{VCOSQ}{C}$$

- ★ where fd is the Reflected frequency
- ★ fo is the initial frequency .
- ★ V – Velocity of blood.
- ★ C – is propagation speed of sound in tissue.

Back scattering is the phenomenon by which Doppler signal processing is done.

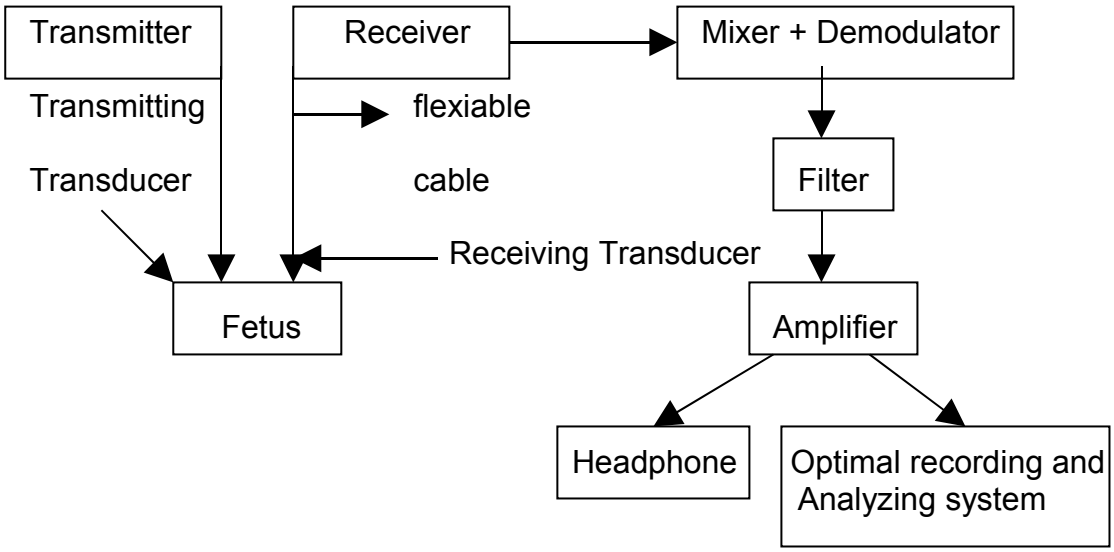
Doppler modes:

A variety of Doppler ultrasound modes are used in the diagnostic instruments. These are

1. Continuous Wave Doppler (CWD)
2. Pulsed Wave Doppler (PWD)
3. Duplex Scanner
4. Two dimensional Doppler Colour Flow Mapping (DCFM)

Continuous Wave Doppler

Satomura, was the first to develop a CW Doppler device. It transmits and receives ultrasound wave continuously



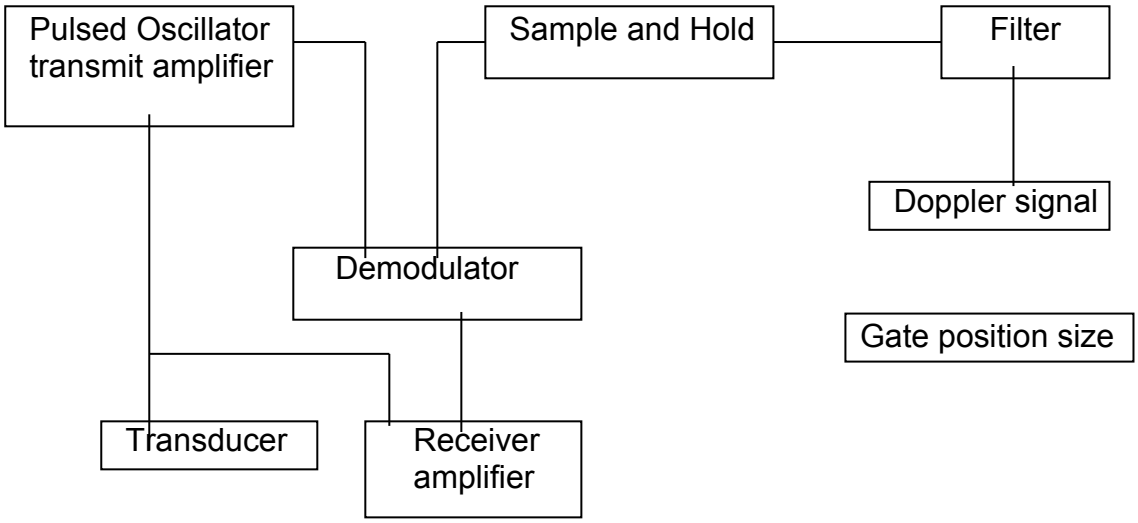
The disadvantage is that the signals are obtained from all moving objects in the line of Doppler beam. It cannot differentiate the locations from which the signals are originating.

Pulsed Wave Doppler(PWD)

The same transducer crystal acts as both the transmitter and the receiver of ultrasound signals. The transducer emits pulses of short bursts of ultrasound energy. Thus the location of the target area can be selected by varying this time delay. This process is known as Range gating.

Components of PWD

It is more expensive and requires high power but allows precise targeting and visualization of the vessel of interest.



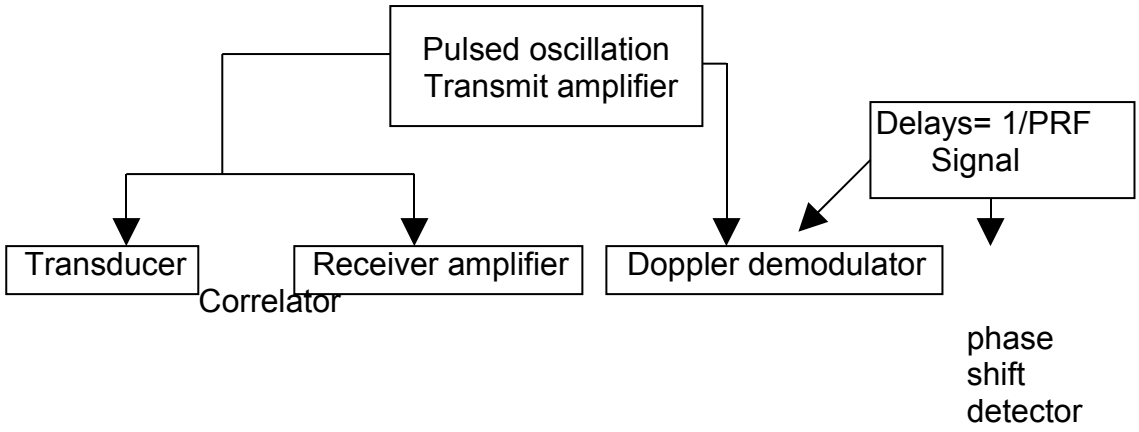
Duplex Scanner

Duplex ultrasound scanners combine Doppler and B mode image and can be used to guide the Doppler beam and blood flow information combined with anatomical and structural information.

Doppler colour flow mapping (DCFM)

DCFM produces a colour coded Map of Doppler frequency shift superimposed on B mode ultrasound image. Flow towards the transducer is coded in red and flow away in blue. Mosaic patterns of red orange (or) blue green represents flow in several directions suggesting turbulence.

Colour flow mapping has been extensively used in adult and echocardiographic investigation. It has also been used in studying flow dynamics in fetal heart.



Filters

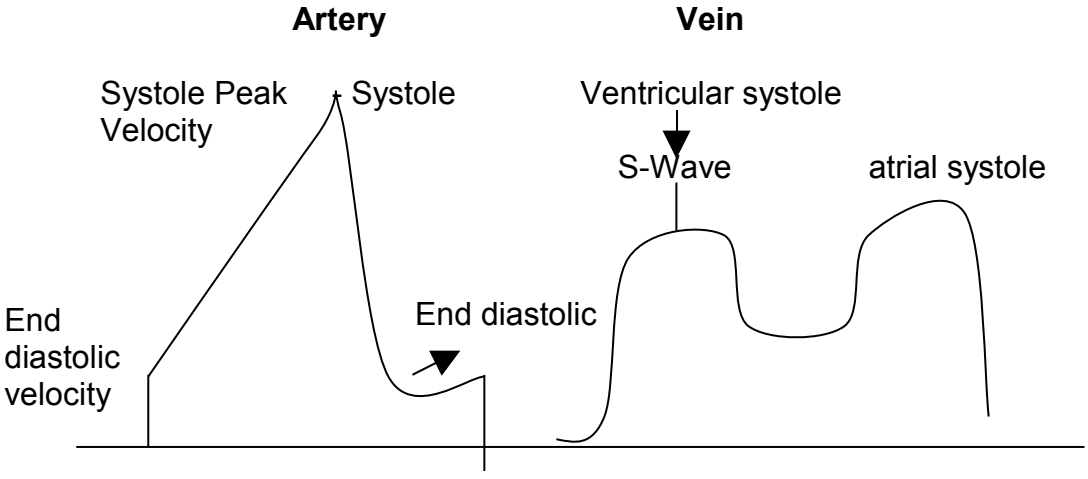
The Doppler signal consists not only of blood flow generated frequency signals but also consists of signals from other sources. These include high amplitude, low frequency signals known as clutter produced by movement of the tissue structures and high frequency noise generated by instruments. These additional sounds are removed by electronic digital filtering.

A low pass filter is used for high frequency noise and high pass filter is used for clutter.

Doppler Waveform Analysis

Doppler frequency shift signals returning from a circulation can provide information on the velocity of blood flow. To determine the velocity, it is necessary to know the angle of beam incidence and to assume that the velocity of ultrasound in tissue and the transducer emission frequency are constant during examination. Because these assumptions are essentially valid, determination of Doppler shift and the angle will yield the velocity value from the Doppler equation.

Various methods of volumetric flow analysis are angle dependent and hence various Doppler indices have been devised as these are angle independent.



Doppler indices for arterial and venous flow velocity waveforms

Doppler indices for Arterial Flow

S/D Ratio = Systolic peak velocity / End Diastolic Velocity

Pulsatility Index = Systolic peak velocity - end diastolic velocity / Mean frequency shift

Resistance Index = Systolic – end Diastolic velocity / systolic peak velocity

Doppler Indices for venous flow

Preload Index = Peak velocity during atrial contraction / Systolic peak velocity

Pulsatility Index Veins (PIV)= Systolic – Diastolic peak velocity / Time averaged maximum velocity

Percentage reverse flow = Systolic time averaged velocity / Diastolic time averaged velocity x 100

The study of fetal vascular anatomy includes

A. Arteries

- ★ Uterine artery
- ★ Umbilical artery
- ★ Middle cerebral artery
- ★ Descending thoracic aorta

B. Veins

- ★ Ductus venosus
- ★ Inferior venacava
- ★ Umbilical vein

Source of variance in Doppler indices

There is progressive fall in impedence with advancing gestation in the fetoplacental circulation, especially after 20 weeks. So there is a continuous increase in end diastolic velocity and concomitant decrease in pulsatility (Maulik 1989) The S/D Ratio, P.I, R.I decreases in a continuous manner throughout the pregnancy. The indices are also affected by fetal breathing, fetal heart rate and the location of measurement.

It is important therefore to assess the umbilical artery Doppler wave form only during fetal apnoea. Statistically significant alterations in the indices secondary to heart rate variations have been documented (Maulik 1989).

Bradycardia increases the diastolic time and reduces the end diastolic velocity. Because the systolic component remains relatively unaltered, S/D Ratio, PI and RI also increase. Tachycardia induces the opposite changes.

Vessels studied is Doppler Analysis of Gestational Hypertension and adverse perinatal outcome

1. Umbilical artery
2. Uterine artery

Umbilical arterial circulation

The umbilical blood flow increases from 8.5ml/mt at 12 weeks to 80 ml/mt at 26 weeks and 300ml/mt at term. The umbilical circulation represents 50% of the fetal cardiac output. In terms of unit weight, the umbilical blood flow is rather constant throughout pregnancy and is at 110 -115ml/min/Kg.

In pregnancies complicated by IUGR umbilical flow is significantly reduced to below the 10^{th} percentile.

For any given gestation, normal umbilical artery flow occurs when there is a normal myocardial function and normal vascular resistance in the placental bed. Women with more acute onset of illness including preeclampsia may have normal (or) mildly abnormal umbilical artery Doppler flows.

The best prognostic capability of the umbilical artery flow assessment is more with chronic disease process (eg.)

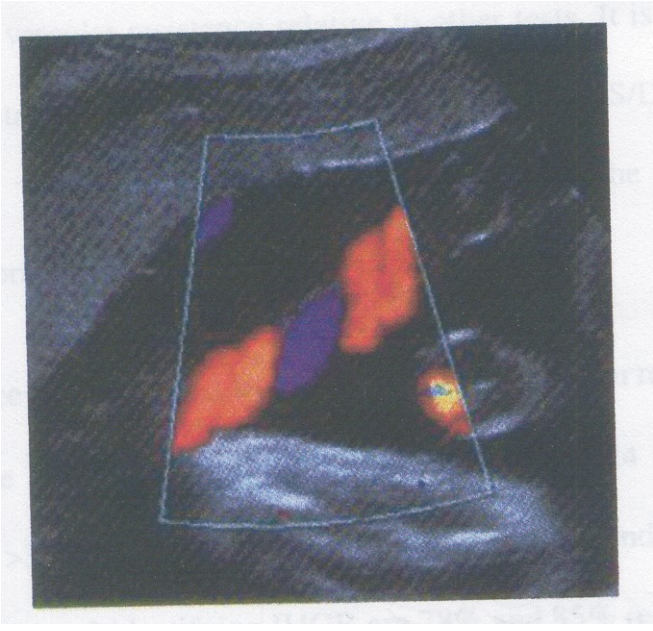
1. PIH developing into preeclampsia
2. Fetal growth restrictions
3. Diabetes complicating pregnancy

Method

The transducer is placed over mother's abdomen overlying the fetus and is systematically manipulated to obtain the characteristic waveforms from the umbilical artery. The location of the Doppler sampling site in the umbilical cord affects the Doppler waveform. Those at the midcord or placental insertion are critically reliable.

Normal Doppler indices of umbilical artery

- ★ S/D Ratio < 3
- ★ RI = 0.5 - 0.7



Ultra sound image with Colour doppler showing the umbilical cord, umblical vein (blue) and umbilical artery (red).

Normally by the 24th week, all fetuses should demonstrate persistent diastolic flow. From this point onwards there is a steady decline in the S/D Ratio extending upto term indicating progressive decline in placental vascular resistance, due to increasing radius of distal blood vessels.

The Doppler umbilical flow waveforms are regarded as early predictors of vascular resistance relative to other tests. It is not till 50% (or) more of resistance vessels are obliterated that the PI (or) S/D Ratio increases significantly.

Significance of abnormal umbilical artery waveforms

S/D Ratio

In the late second and third trimesters after 24 weeks, the S/D Ratio>3 is considered abnormal. The sensitivity and specificity of an S/D ratio>3 in identifying IUGR due to preeclampsia are 78% and 85% respectively.

Absent End Diastolic flow (AEDF)

Incidence of maternal hypertensive disorders complicating pregnancy with AEDV is 50%. The median interval between the appearance of AEDV and abnormal fetal heart rate tracings is about 1 week with very wide individual variability.

The effectiveness of the umbilical arterial S/D Ratio for predicting adverse perinatal outcome was investigated by Trudinger et al. The parameters of fetal compromise induced birth weight below 10th percentile or an Apgar score of < 7 at 5 minutes. In this study, umbilical arterial S/D Ratio appeared to be more sensitive but less specific than electronic fetal heart rate monitoring.

The measures of outcome included IUGR, fetal distress, caesarean section for fetal distress and admission to the NICU.

It is noteworthy that pregnancies complicated by both growth retardation and hypertension demonstrate a greater propensity for developing AEDF than those with either growth retardation (or) hypertension alone.

The AEDV identified acidosis with a sensitivity of 90% specificity 92%, positive predictive value 53% and negative predictive value 100% (Nicolaides and associates)

It appears that progressive fetal haemodynamic decline as manifested by umbilical arterial AREDV is not necessarily related to fetal asphyxia and presents a serious threat to the fetus independent of fetal hypoxia or acidosis.

Reversal of end diastolic flow (REDV)

REDV indicates extremely increased placental vascular impedence. Incidence of perinatal mortality rate with REDV is 35.7%. In AEDV, S/D ratio is infinity and cases with reversal of flow cannot be diagnosed by S/D ratio. Hence use of PI has been suggested as an alternative to circumvent this problem.

Limitation of Doppler indices - Technical pitfalls is the diagnosis of AEDV

1. AEDV may be missed when high pass thump filter is used.
2. If an inappropriately high angle insonation is selected AEDV can be made mistakenly.
3. AEDV should be confirmed by sampling multiple sites and angles
4. Reversal of Diastolic flow cannot be identified with unidirectional Doppler machine.

Causes of false negative waveforms

- ★ In mothers with acute onset of illness including preeclampsia or intrauterine infection may have normal or mildly abnormal umbilical artery Doppler flows even though fetal condition may be deteriorating.
- ★ Fetal tachycardia causes very short time for Diastolic filling.

  ADEV may be missed if HR > 160/mt. Ideal heart rate for measuring end diastolic velocity will be 120-160/mt.

Causes of false positive waveforms

First trimester and early second trimester scan may give false positive waveforms. Fetal bradycardia increases diastolic time (or) reduces end diastolic velocity could lead to false diagnosis of AEDV.

Umbilical artery Doppler indices Normal Range

Weeks of gestation (in weeks)	PI	RI	S/D Ratio
28	0.8 – 1.5	0.58 – 0.76	2.1 – 4.8
30	0.76 – 2.5	0.56 – 0.74	2.0 – 4.0
32	0.72 – 1.20	0.54 – 0.72	1.9 – 3.8
34	0.70 – 1.15	0.50 – 0.70	1.9 – 3.5
36	0.68 – 1.10	0.48 – 0.68	1.8 – 3.3
38	0.64 – 1.00	0.46 – 0.66	1.8 – 3.0
40	0.60 – 0.95	0.44 – 0.64	1.7 – 2.8

Uterine Artery Flow Velocity Waveforms

Lack of endovascular infiltration by trophoblasts into the myometrial portion of the placental bed spiral arteries is a consistent finding in preeclampsia.

The findings reported in the original article of Campbell et al in 1983 on uteroplacental Doppler velocimetry had a higher frequency of proteinuric hypertension, poor fetal growth and fetal hypoxia.

Indices of uterine artery waveform analysis

Uterine artery waveforms are analysed by simple semi quantitative techniques based on Doppler shift frequencies. Three widely used indices are

★ **Pulsatility Index (PI)** is the most complex of the three.

$$= \frac{\text{Peak systole – end diastole}}{\text{Mean value of the area under the curve over one cardiac cycle}}$$

This index has an advantage when analyzing complex wave forms that have absent (or) reverse flow during systole.

Other simpler indices are

★ **S/D Ratio**

The main problem with S/D Ratio is that it becomes infinity when there is no or reversed end diastolic velocity.

★ **RI (Resistance Index)**

Uterine artery mean RI decreases from 0.8 at 8 weeks to around 0.63 at 17 weeks.

★ **Early Diastolic Notch**

In the non-pregnant state, the uterine artery waveform exhibits high pulsatility with a rapid rise and fall in frequency shifts during systole, and an Early diastolic notch.

Pregnancy results in marked changes in the uterine artery waveform from 26th week onwards, normally the S/D Ratio value does not change throughout the reminder of the pregnancy.

The diastolic notch disappears by 20 – 26 weeks. So the full evolution of the uterine artery waveform is complete only after 26 weeks. So abnormal uterine artery waveforms are those with

1. S/D Ratio > 2.8 (the average of right and left uterine arteries)
2. Persistence of early diastolic notch

The mean averaged S/D Ratio for each trimester were,

- I trimester 5.5,
- II trimester 2.9,
- III trimester 2.1.

Deutinger et al believed that the S/D Ratios plateaued at 24 weeks. Retention of the early diastolic notch is thought to represent persistence of the inherent total high impedence of the uterine artery circulation.

When normal pregnancy outcome was defined as delivery at $\geq$ 37 weeks (or) a birth weight > 2.5Kg, the uterine artery notch had a better sensitivity of 93%, specificity 91%, positive predictive value 87% and negative predictive value 95%. Aristidou et al noted that the uterine artery notch was a good predictor of poor perinatal outcome.

Influence of placental location on uterine artery waveforms

In case of lateral placenta, the placental uterine artery shows low Resistance flow.

Schulman et al developed the concept of divergent uterine arteries. They found that normal pregnancies were associated with more (or) less equal contributions from each uterine artery and the normal S/D Ratio difference between them was 0.3 $\pm$ 0.3. Accordingly divergent uterine arteries were defined as those with S/D Ratio difference of $\geq$ 1.

Rofinas et al found that the perinatal outcome correlated best with placental uterine artery, the mean index using both uterine arteries, the next best condition, and the non placental uterine artery the poorest predictor. Persistence of the uterine notch indicates severe hypertensive disease and its presence in III trimester is associated with increased rate of IUGR, caesarean delivery for fetal distress and preterm delivery.

Thaler et al reported that presence of early diastolic notch is significantly better predictor of poor pregnancy outcome than the S/D Ratio (or) the RI and, that an increased uterine artery RI without a notch poorly correlates with adverse fetal outcome.

The difference in the main uterine artery waveform indices between normal and pathologic pregnancies is probably greater than at other sites of uterine artery. Measurement of the main uterine artery may be more

reproducible and allows standardized longitudinal followup, because it is a reflector of total sub placental resistance, remains the most clinically important parameter.

The findings of the uterine artery screening study shows that it is an effective means of predicting preeclampsia associated with delivery before 34 weeks of gestation.

The prevalence of the perinatal outcome measured will have the biggest impact as will the definition of abnormal uterine Doppler velocimetry. The data suggests that the presence of the notch is the most important criterion.

It has been noted that AEDV preceeds CTG abnormalities by an average of 8 days. (Schulmann et al 1984,Trudinger et al 1985, 1986 Rochelson et al 1987b ,Cameroon et al 1988)

According to Arduini et al (1993) gestational age proved to be the powerful prognostic indicator of the duration of the time interval between AEDV and delivery with longer intervals in earlier gestation than later gestation.

The best sensitivities of the uterine artery waveforms are for the pregnancies with the worse outcomes such as early onset of hypertension, proteinuric hypertension and hypertension associated with IUGR.

MATERIALS AND METHODS

MATERIALS AND METHODS

This prospective study for the evaluation of the effectiveness of Doppler studies in PIH with relevance to perinatal outcome was undertaken at Govt. Rajaji Hospital, Madurai Medical College in the Department of Obstetrics and Gynaecology during the year January 2005 to February 2006.

Case Selection

Among the pregnant mothers attending antenatal OPD, high risk patients were screened for gestational hypertension and preeclampsia. 50 pregnant patients with Gestational hypertension and preeclampsia were selected and admitted for management at Govt. Rajaji Hospital. They were selected for the Doppler study. All the patients recruited for the study had systolic blood pressure of > 140 mmHg and diastolic blood pressure of > 90 mmHg. The gestational age during the study was 36-40 weeks.

Importance was given to the following Inclusion and exclusion criteria.

Inclusion criteria

i. Gestational hypertensives (ie) onset of Bp > 140/90 after 20 weeks for the first time in pregnancy.
ii. Mild and severe preeclampsia with proteinuria as main feature.

Exclusion criteria

Women with twin pregnancy or chromosomal abnormalities, Idiopathic IUGR/ Gestational diabetes, presence of reverse waveform were excluded from the study. Also chronic hypertension complicating pregnancy, chronic renal disease complicating pregnancy, SLE complicating pregnancy were excluded.

Those patients in whom regular follow up to term and delivery was not possible were excluded from the study. Umbilical artery and Uterine artery Doppler evaluation is performed routinely in our Department for all pregnancies complicated by PIH admitted for inpatient care.

Method of Study:

In all patients, a thorough general and obstetric history was elicited and a complete general and obstetric examination was done. All the patients were monitored and for four hourly blood pressure recordings, daily urine analysis, twice weekly blood urea and uric acid and fundus examination. Liver function tests, platelet count, electrolytes, complete hemogram were done once in a week.

These investigations were repeated as and when necessary till delivery. Fetal surveillance was done with daily fetal movement count, twice weekly NST and modified Biophysical profile. Further management was

done depending upon the severity of preeclampsia and condition of the cervix.

USG and Doppler flow velocimetry of umbilical and uterine artery were studied at term, and the mode of delivery, fetal outcome were studied, documented and analysed. Doppler study was performed in a prospective study.

In the obstetric examination, Uterine fundal height and abdominal girth were measured. Fetal heart rate counted. IUGR was diagnosed if there is > 2cm difference in Symphysio fundal height to the clinical gestational age.

Method of Doppler Study:

Doppler ultrasound examination was performed by means of a Duplex Doppler system with 2.42MHZ pulsed Doppler transducer attached to 3.5MHZ linear array transducer at a fixed angle.

A 100HZ thump filter was used to eliminate Doppler shift frequencies caused by vessel wall movements.

During Doppler evaluation, the pregnant woman is made to lie in a semi recumbent position with a slight lateral tilt, to minimize the risk of developing supine hypotension syndrome due to venacaval compression.

By this method, umbilical and uterine arteries were studied and the waveforms obtained. Peak systolic and end diastolic velocities were measured and S/D Ratio calculated by the method of Stuart –et-al.

Umbilical Artery

The umbilical artery is assessed by pointing the probe towards the fetus through the abdomen. Flow velocity waveforms were recorded from the free floating loop of cord.

Abnormal waveforms:

- ★ S/D Ratio > 3
- ★ Reduced/Absent end diastolic flow
- ★ Reversed end diastolic flow.

Uterine Artery

The main branch of the uterine artery can be detected by placing the probe above the Inguinal Ligament searching for the characteristic sound of the uterine artery flow velocity waveforms.

Follow up of cases

- ★ **Maternal indications** for termination of pregnancy included uncontrolled hypertension, abruption, deteriorating renal function and Hellp syndrome.

★ **Fetal indications for termination -** Evidence of fetal distress either by Biophysical profile or abnormal CTG.

The mode of delivery, Gestational age at delivery, Whether delivery was Induced or spontaneous were noted. If induced, indication for Termination / mode of delivery – Labor Natural / elective / emergency LSCS were noted.

The following were taken as adverse perinatal outcome**.**

1. Preterm delivery
2. Birth weight < 10^{th} percentile below the mean for gestational age.
3. Apgar at 5 minutes < 7/10
4. Caesarean section done for fetal distress.
5. Admission to NICU.
6. Presence of Respiratory Distress, Hypoxic ischemic encephalopathy, intraventricular haemorrhage. necrotising enterocolitis, seizures.
7. Perinatal deaths.

OBSERVATION AND ANALYSIS

OBSERVATION AND ANALYSIS

One of the main features of preeclampsia is abnormal placentation due to inadequate trophoblastic invasion of maternal spiral and Radial arteries.

The pathophysiology behind the lack of vessel adaptation in preeclampsia and IUGR is unknown; but a maternal fetal genotype interaction is the most likely alternative.

- ★ Total Cases 50
- ★ Mild PIH 10
- ★ Severe PIH 18
- ★ Preeclampsia 20
  - Mild 10
  - Severe 10
- ★ Eclampsia 2

The following observations were made.

Table 1: Age Distribution

Age	No. of cases	Percentage
18-20	10	20
21-29	37	74
30-35	3	6

In our study 74% (37/50) belonged to the age group of 21-29 years and teenage girls were affected in 20% (10/50) of the cases and in 6% (3/50) were 30 years and above.

Duen Holter reported that pregnancy induced hypertension was common in very young teenage and Guzick and associates in 1987 reported that it was common in older women 30-35 Years of age. Spellacy in 1986 reported that it was common in 40 years.

Hansen in 1986 Reported that there was a three fold increase in the nulliparas over 40 compared to those 25-29 Years old. Here in this study according to table I the maximum age incidence is between 21-29 Years.

Table 2: Gravidity and PIH

Gravidity	No. of cases	Percentage
Primi	28	56
G II	3	6
G III	15	30
G IV	4	8

In our study 56% (28/50) were primi gravidas, 44% (22/50) were multigravidas.

This correlated with the study of Chesley et al - where they found higher incidence of PIH in nulliparas - 70%.

Table 3: Relationship between Living area and PIH

Living area	No. of cases	Percentage
Rural	33	66
Urban	17	34

66% (33/50) of the cases were from rural areas 34% (17/50) of the cases were from urban areas. The rural patients were most affected because of their irregularity in antenatal care and prevailing dietary deficiency in those group.

Urban people were less affected because of better antenatal care, early detection and appropriate treatment.

Booking / Socio economic status

In the present study almost all the cases belonged to lower socio economic status. 16% of them were only booked cases and 94% of them were unbooked cases. The same pattern was also observed in the developing countries as reported by Odour et al 1991.

Only 16% (8/50) were booked cases. The next of the 94% (47/50) were unbooked cases.

Table 4: Classification of PIH studied

Type of PIH	No. of cases	Percentage
Mild PIH	10	20
Severe PIH	18	36
Mild preeclampsia	10	20
Severe Preeclampsia	10	20
Eclampsia	2	4

- Out of the 50 cases studied 20% (10/50) constituted mild PIH Cases.
- 36% (18/50) constituted severe PIH cases.
- Pre eclampsia was seen in 40% (20/50)
- Eclampsia in 4% (2/50)

A widely quoted study by Friedman and Neff (1976) showed that diastolic hypertension of > 95 mmHg was associated with 3 fold increase in fetal death.

The diastolic pressure is a more reliable prognostic sign than the systolic pressure according to Cunnigham et al 1989.

Table 5: Other Complications Coexisting

Type of complications	Study No.	Percentage
Anemia	10	20
Oligohydramnios	20	40
Accidental Haemorrhage	6	12
RH Negative	2	4
Eclampsia	2	4
Cord around the neck	3	6

Complications associated with PIH

When analysed in our study group it was found that anaemia was seen in 20% (10/50), Accidental Haemorrhage was seen in 12% (6/50) Oligohydramnios was observed in 40% (20/50), and 4% (2/50) developed eclampsia. None of the cases went in for HELLP Sydrome.

Correlation between proteinuria and PIH

Proteinuria	No. of cases	Percentage
Nil	30	60
Mild	10	20
Severe	10	20

In the present study 60%(30/50) did not have proteinuria since they had mild to severe gestational hypertension. 20% (10/50) of the cases had mild proteinuria of 1+ and the all belonged to mild PIH cases. Severe proteinuria was present in 20% (10/50) of the cases and they all belonged to mild and severe pre eclampsia.

Newman and coworkers (in 2003) reported that worsening hypertension especially if accompanied by proteinuria was more ominous sign and results in increasing preterm delivery.

Blood parameter

Renal Parameters

Type of PIH	Serum creatinine					
	< 1 mg		1-2 mg		> 2 mg	
	No.	%	No.	%	No.	%
Gestational Hypertension	18	36	9	18	1	2
Pre Eclampsia	3	6	9	18	8	16
Eclampsia	-	-	-	-	2	4

Pritchard and colleagues in 1984 Reported that in severe preeclampsia, plasma creatinine may be elevated up to several times the non pregnant value.

Table 8: SR Uric acid

Serum Uric Acid	No. of cases	Percentage
3.5 mg	5	10
3.5-4.5 mg	28	56
4.5-6 mg	17	34

Uric acid is the end product of purine metabolism. Elevated Serum urine acid levels are due to decreased renal rate excretion.

In the present study increased serum uric acid levels were found more in mild and severe pre eclampsia cases.

- ★ Jacobson and colleagues in 1990 found that plasma uric acid values exceeding 5-9 mg/dl at 24weeks had a positive predictive value for preeclampsia of 33%
- ★ Redman et al 1976 suggested that serum uric acid is a useful indicator of the risk.

Table 9: Fundus (Hypertensive Retinopathy)

Fundus	No. of cases	Percentage
Normal	38	76
Grade I (Hypertensive retinopathy)	9	18
Grade II	2	4
Grade III	1	2
Grade IV	Nil	Nil

In our study fundus examination was normal in 38 (76%) of cases. Grade I was seen in 9 (18%) of the cases, Grade II in 2 (4%) cases and Grade III in 1 (2%) case. All the grade II and Grade III were noted in severe pre eclampsia and eclampsia cases.

Spectrum of visual disturbances range from blurring of vision to partial or complete blindness. It is due to vasospasm and ischemia. Rarely permanent visual defect may be caused by cerebral infarctions or retinal artery infarction.

Table 10

Relationship between liquor volume and PIH

Liquor Volume	No. of cases	Percentage
Nil	27	54
Increased	3	6
Decreased	20	40

Because of reduced placental perfusions, amniotic fluid is decreased. The incidence of oligohydroaminos in the present study is 40%

Table 11

IUGR by USG - Estimated Fetal Weight

By EFW	No. of cases	Percentage
IUGR	11	22
AGA	39	78

Out of 50 patients of PIH, in 35 of those with abnormal Doppler flow, when ultrasonographic Estimated fetal weight < 10^{th} percentile was used. 22% were found to have IUGR.

Table 12

Relationship between Doppler study of umbilical and uterine arteries and gestational hypertension

Doppler Study	Study Group	
	No.	%
Normal Doppler	15	30
Abnormal Doppler	35	70

The Doppler study was normal in 30% of the cases, 10 of the mild PIH cases and 5 of the severe PIH cases. There was positive Doppler finding in 70% of the cases and all belonged to severe PIH, preeclmapsia and eclampsia cases.

Table 13

Type of Doppler abnormality in umbilical artery

Type of abnormalities	Study Group	
	No.	%
High resistance flow or increased S/ D Ratio (>3)	10	28.57
AEDF	5	14.28
REDF	3	8.57

In our study out of the 35 patients with abnormal Doppler flow in umbilical artery High resistance flow was noted in 28.5% of the cases, Absent end diastolic flow was noted in 14.2% of the cases and all the cases were severe pre eclampsia cases. Reversal of end diastolic flow was noted in 8.5% of the cases, all of them belonged to severe pre eclampsia and eclampsia group. REDF indicates impending fetal demise in 48 hours. All the cases who had AEDF and REDF also had early diastolic notch in uterine artery waveforms.

Table 14

Type of Doppler abnormality in uterine artery

Type of abnormality Total	Study Group	
	No.	%

S/D Ratio increase	10 (10/35)	28.57
Early diastolic notch	7 (7/35)	20

According to Thaler et al an early diastolic notch persists after 26 weeks of gestation in 25-40% of hypertensive pregnant women. Presence of the notch is a significantly better predicator of poor pregnancy outcome than the S/D Ratio (or) the RI.

In our study early diastolic notch was present in 20% of the positive Doppler cases. According to Arduini et al (1993) gestational age proved to be the powerful prognostic indicator of the duration of the time interval between AEDV and delivery. In our study, all the 5 cases with AEDF were delivered within 48 hours and all were above 37 weeks of gestation.

Aristidou et al noted that the uterine artery notch was a good predicator of poor perinatal outcome – increased rate of IUGR, Caesarean delivery for fetal distress and preterm delivery. In our study, out of the 7 cases with early diastolic notch – 4 cases that is 67% of the cases had IUGR but they also had umbilical artery abnormal wave forms.

Similarly, in this study, 42.5% of those with early diastolic notch went in for emergency LSCS for fetal distress. 14% of those who had diastolic notch had spontaneous preterm delivery, and the babies were admitted in preterm ward with complications of prematurity.

Table 15

Mode of delivery and Umbilical artery flow pattern

Umbilical flow patterns	Mode of delivery			
	Vaginal		Caesarean section	
	No.	%	No.	%
High resistance flow (increased S/D Ratio) (10)	8	80	2	20
AEDF (5)	2	40	3	60
REDF (3)	1	33.33	2	66.6
Normal (32)	26	81	6	19

In the present study among the cases with abnormal umbilical artery flow, 2 cases with increased S/D Ratio underwent elective LSCS for abnormal CTG. Out of the 5 cases with AEDF, 3 cases went in for emergency LSCS. All the 3 emergency LSCS were done for IUGR with oligo hydramnios with fetal distress. Only 2 babies could be salvaged. One baby expired 5 hours after birth due to Meconium aspiration syndrome.

The other 2 cases of AEDF were induced with PGE_2 gel. Both the babies had birth asphyxia and were admitted in NICU.

In the present study among the 3 cases with Reversal of end diastolic flow 2 cases went for emergency LSCS for fetal distress. Both the babies expired due to severe Respiratory distress and Meconium aspiration. The remaining one case with reversal of diastolic flow was still born.

Table 16

Uterine artery flow pattern and Mode of delivery

Uterine flow pattern	Mode of delivery	
	Vaginal	Caesarean section
Increased S/D Ratio (10)28.57%	8(80%)	2(20%)
Early diastolic notch (7) 20%	4(57.1%)	3(42.9%)
Normal	30	3

In the present study abnormal uterine artery waveform pattern was seen in 17 cases. 7 cases had early diastolic notch in uterine artery. Out of these 3 cases underwent LSCS out of which one was emergency LSCS for fetal distress. In other 2 cases - elective LSCS was done, for obstetrical indications.

Among the 10 cases which had high resistance flow in uterine artery LSCS was done in 2 cases. Both elective surgeries - one for IUGR with oligohydramnios and other one for severe CPD.

Mode of Induction

- ★ No interference 7
- ★ ARM with Oxytocin induction for abruption placenta 2
- ★ PGE_2 Cerviprime gel induction 6

Mode of Delivery

- ★ Labor natural 11

★	Outlet forceps	4
★	Emergency LSCS	6
★	Elective LSCS	6

Table 17

Umbilical artery and perinatal outcome

Umbilical artery	Perinatal outcome	
	Abnormal	Normal
Abnormal (18)	16 (88.8%)	2 (11.2%)
Normal (32)	2 (6.25%)	30(93.75%)

On gross analysis of the perinatal outcome with abnormal umbilical artery Doppler, when the flow is abnormal, 88.88% (18/35) had abnormal perinatal outcome and only 11.11% (2/35) had normal outcome. Whereas when the flow was normal, 93.75% (30/32) had normal babies and only 6.25% (2/32) had abnormal perinatal outcome.

Umbilical artery flow velocity waveforms correlate with hemodynamic changes in the fetoplacental circulations. Increased impedence to the blood flow in the umbilical artery is significantly associated with IUGR and perinatal morbidity and mortality. The present study shows that the umbilical artery flow velocity study to be significant in detecting abnormal perinatal outcome.

When there is high resistance flow in umbilical artery, 80% had abnormal perinatal outcome and 20% had normal outcome.

1. According to Fleisher et al 1989, umbilical artery S/D Ratio has a sensitivity of 78%, specificity of 83%, positive predictive value of 66%

and negative predictive value of 95% in determining adverse perinatal outcome.

2. According to OZeren M et al Eur Obstet Gynaecol Reprod biol. – 1999, Jan the umbilical artery S/D Ratio has the highest sensitivity 88% and diagnostic accuracy 94% in predicting adverse perinatal outcome.

3. Arora Devendra et al at Bombay Hospital Institute of Medical Sciences conducted a study of umbilical artery velocimetry in IUGR fetuses – concluded growth restricted fetuses with normal umbilical flow velocimetry are at lower risk than those with abnormal velocimetry in terms of poor Apgar Score, NICU admissions, need for PPV etc. BMJ Obstet Gynecol Volume 55 April/2005

4. G.S Berkowitz et al in his study ACGO 1988 concluded that Doppler umbilical velocimetry studies are valuable in identifying those fetuses with growth restriction due to several causes are at increased risk for adverse perinatal outcome.

5. Trudinger et al Br J Obstet Gynecol 1990 Feb according to him, abnormal fetal umbilical artery Doppler correlates with adverse perinatal outcome in severe proteinuria (PIH) (Preeclampsia) more than the urtheroplacental bed artery velocimetry.

Table 18

Doppler study in umbilical artery and Perinatal outcome

Umbilical artery Doppler (Total = 18)	**Perinatal Outcome**							
	Normal		**Abnormal**					
			Total		**PN Mortality**		**PN Morbidity**	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
High resistance flow increased S/D Ratio (10) (55.5%)	2	20	8	80	2	20	6	60
AEDF (5) (27.7%)	-	-	5	100	2	40	3	60
REDF (3) (16.6%)	-	-	3	100	3	100	-	-

When the correlation between the perinatal outcome and each variable of the abnormal umbilical artery doppler flow were analysed it was found that, when there was high resistance flow (10/18) perinatal mortality is 20% (2/10) and perinatal morbidity is 60% (6/10).

With Absent end diastolic flow pattern in umbilical artery the perinatal mortality is 40% and morbidity is 60%. Whereas with reversal of diastolic flow in umbilical artery 100% perinatal mortality is observed.

Table 19

Perinatal morbidity pattern

Abnormal Umbilical artery doppler	Apgar at 5 m < 7/10		Meconium aspiration		Preterm		SGA	
	No.	%	No.	%	No.	%	No.	%
High/resistance flow/ increased S/D Ratio (6)	2	33.3	1	16	2	33.3	4	66.6
AEDF (3)	3	100	1	33.3	-	-	3	100
REDF (0)	-	-	-	-	-	-	-	-

In our study on analyzing the perinatal morbidity pattern it was found that out of the 6 babies which had High resistance flow, 4 cases were Small for gestational age babies with Apgar < 7/10 at 5 mts, 2 babies were preterm with Meconium aspiration syndrome. All these 6 babies were admitted in NICU for 1 week - 10 days.

When there was Absent end diastolic flow all the 3 cases had IUGR/ Small for gestational age with Apgar at 5 mts < 7/10 and one of them had meconium stained liquor during caesarean section. When there was REDF, all the babies died, 100% perinatal mortality.

Table 20

Uterine artery and Perinatal outcome

Uterine artery

Uterine artery Doppler	Perinatal outcome			
	Normal		Abnormal	
	No.	%	No.	%
Normal (33) 76%	31	95.93	2	6
Abnormal (17) 34%	8	47	9	52.9

In the present study, on gross analysis of the perinatal outcome with abnormal uterine artery flow, when the flow was abnormal only 52.9% had abnormal outcome and 47% had normal outcome. Whereas when the flow was normal 93.93% had normal babies and only 6% had adverse perinatal outcome.

Table 21

Uterine artery Doppler	Perinatal Outcome							
	Normal		Abnormal					
			Total		PN Mortality		PN Morbidity	
	No.	%	No.	%	No.	%	No.	%
Increased S/D Ratio (10)	8	80	2	20	-	-	2	20
Early diastolic notch (7)	-	-	7	100	3	42.8	4	57.14

On analysing the perinatal outcome with abnormal Doppler flow variables in uterine artery, with increased S/D ratio, the perinatal morbidity rate is 20% (2/10) and no perinatal mortality. Whereas with early diastolic

notch in the uterine artery perinatal morbidity rate is 57.14% and the perinatal mortality rate is 42.8%.

On critical analysis, when there is increased S/D Ratio in the uterine artery, 80% (8/10) had normal babies and only 20% (2/10) had adverse perinatal outcome.

Out 20% of the babies who had adverse perinatal outcome both babies were admitted in NICU for 1 week due to prematurity whereas when there is early diastolic notch almost all the babies had adverse perinatal outcome. 3 babies were admitted in NICU for birth asphyxia. Another 4 babies died on II Post natal day due to HIE and neonatal seizures and 1 baby was still born due to meconium aspiration and fetal distress. So with early diastolic notch the perinatal mortality rate is 57.14%

Thaler et al demonstrated that perinatal outcome was worse when there was a diastolic notch and it represents the persistency of inherent total high impedence of the uterine artery circulation. – Amj obstet gynecol 162 1990.

Fleischer et al in his study concluded that when normal pregnancy outcome was defined as delivery at $\geq$ 37 weeks or birth weight of $\geq$ 2.1 kg, the uterine artery notch had a better sensitivity of 93%, specificity of 91%,

positive predictive value of 87% and negative predictive value of 95%. Amj obstet gyencol – 1986 157.

Table 22

Perinatal morbidity pattern

Abnormal uterine artery doppler	Apgar at 5 m < 7/10		Meconium aspiration		Preterm		SGA	
	No.	%	No.	%	No.	%	No.	%
High resistance flow/increased S/D Ratio (2)	1	50	1	50	2	100	-	-
Early diastolic notch (4)	4	57.14	2	28.5	1	14.2	4	57.4

Out of 4 babies which had Early diastolic notch all the 4 had low apgar and all were SGA and 2 of them had MAS and were admitted in NICU. All 4 had both Apgar < 7/10 and SGA.

On analyzing the type of perinatal morbidity with abnormal uterine artery Doppler, with high S/D ratio both the babies went in for pre term delivery with one of the baby meconium aspiration syndrome and the other one Apgar < 7/10 at 5 mts and both were admitted to NICU Ward, discharged after 1 week of intensive care.

With early diastolic notch, 4 babies had Apgar < 7/10 at 10 mts and they were SGA infants. Two of the babies also had meconium aspiration with fetal distress intrapartum.

All the 4 babies were admitted to NICU Ward kept under observation for 10 days and later discharged long term follow up was not done in my study.

Table 23

Abnormal Doppler and Birth Weight

	Abnormal Doppler	Birth weight (kg)							
		≤ 1.5		1.6-2		2-2.5		>2.5	
		No.	%	No.	%	No.	%	No.	%
Uterine artery	Increased S/D Ratio (10)	-	-	1	10	2	20	7	70
	Early diastolic notch (7)	-	-	3	42.8	4	57.4	-	-
Umbilical artery	High resistance flow (10)	-	-	2	20	5	50	3	30
	AEDF (5)	1	20	2	40	2	40	-	-
	REDF (3)	-	-	2	66.6	1	33.3	-	-

Analysis of the uterine artery abnormal Doppler and birth weight, with increased S/D Ratio 70% of the babies had birth weight ≥ 2.5 kg term babies with early diastolic notch, 57% of the babies had birth weight 21-72.5 kg and the rest 42% had birth weight < 2 kg.

Analysis of abnormal umbilical artery and birth weight showed with high resistance flow > 50% of the babies had birth weight between 2.1-2.5 kg and 20% had birth weight < 2 kg.

With AEDF all the babies who had birth weight < 2.5 kg nearly 85% of the babies had fetal growth restrictions. With REDF almost 100% of the babies had the birth weight < 2.2 kg were severe IUGR babies and all died.

In the present study totally there were 16 IUGR babies of which 3 cases had REDF, 4 cases had AEDF in umbilical artery, 2 cases had early diastolic notch in the uterine artery.

Table 24

Mortality and Salvage rate

Uterine artery and abnormal Doppler

Outcome	High resistance flow or increased S/D ratio (10)	Early diastolic notch (7)
Salvage	8+2 (20%) (10/10)	4/7 (57.14%)
Mortality	-	3/7 (42.85%)

On analyzing the mortality and salvage rate in babies with abnormal uterine artery wave forms, with increased S/D ratios, 80% of the babies were born normally and only 2 had NICU Admission but could be salvaged. Whereas with early diastolic notch 42.84% fo the babies died and only 4 babies could be salvaged. The salvage rate is 57.14%

Table 25

Mortality and Salvage rate

Umbilical artery and abnormal Doppler

Outcome	High resistance flow or increased S/D ratio (10)	AEDF (5)	REDF (3)
Salvage	8 (80%)	3 (40%)	-
Mortality	2 (20%)	2 (60%)	3 (100%)

On analyzing the mortality and salvage rate with abnormal umbilical artery wave forms, 80% babies were salvaged.

With AEDF perinatal mortality rate is 60% and salvage rate is 40%. With REDF 100% perinatal mortality and no babies could be saved.

STATISTICAL SIGNIFICANCE OF DOPPLER STUDIES

- Total no. of cases 50
- Normal Doppler 15
- Abnormal 35

Uterine artery and perinatal outcome

	Perinatal Outcome	
	Abnormal	**Normal**
Abnormal (17)	9 (a)	8 (b)
Normal (33)	2 (c)	31(d)

Sensitivity = $\frac{\text{True positive}}{\text{True positive + False negative}} \times 100$

= $\frac{9}{11} \times 100$

= 82%

Specificity = $\frac{\text{True negative}}{\text{False positive + True Negative}} \times 100$

= $\frac{31}{39} \times 100$

= 79%

Positive predictive value = $\frac{\text{True positive}}{\text{True positive + false positive}} \times 100$

= 9 x 100
17

= 53%

Negative predictive value= True Negative x 100
True negative + false negative

= 31
33

= 94%

False positive % = b x 100
b+d

= 8 x 100
39

= 20%

False negative % = c x 100
a+c

= 2 x 100
11

= 18%

The present study shows that the uterine artery flow velocimetry is significant in detecting abnormal perinatal outcome, with the sensitivity of 82%, specificity 80%, Positive predictive value of 53%, Negative predictive value of 94%, False positivity rate of 20% and false negative rate of 18% .

Moreover almost 30% of the patients who had abnormal uterine artery Doppler velocimetry also had abnormal umbilical artery velocimetry.

In our study uterine artery notch appears to be a good predicator of poor perinatal outcome. All the patients who had early diastolic notch had abnormal perinatal outcome. That is 67.14% of the babies had Apgar at 5 mts < 7/10, 28.57% of the babies had meconium aspiration syndrome. 14% of the babies had preterm deliveries and its complications and 57% of the babies were small for gestation age and 3 babies (42.85%) died.

According to Fleischer et al when normal pregnancy outcome was defined as delivery at >37 weeks or a birth weight of > 2.5 kg, the uterine artery abnormal waveforms had better sensitivity of 93%, specificity 91%, PPV 8% and NPV 95%.

Campbell and colleagues in 1983 showed that compared to pregnancies with normal uterine artery waveforms, pregnancies with abnormal uterine artery waveforms were associated with more protenurine hypertension, required more anti hypertensive treatment and adverse perinatal outcome.

Statistical significance of umbilical artery Doppler

	Perinatal Outcome	
	Abnormal	**Normal**
Abnormal (18)	16 (a)	2 (b)
Normal (32)	2 (c)	30(d)

Sensitivity = $\frac{\text{True positive}}{\text{True positive + False negative}} \times 100$

= $\frac{16}{16+2} \times 100$

= 89%

Specificity = $\frac{\text{True negative}}{\text{False positive + True Negative}} \times 100$

= $\frac{3}{2+30} \times 100$

= 94%

Positive predictive value = $\frac{\text{True positive}}{\text{True positive + false positive}} \times 100$

= $\frac{16}{16+2} \times 100$

= 89%

Negative predictive value = $\frac{\text{True Negative}}{} \times 100$

True negative + false negative

= 3 x 100
2+30

= 94%

False positive % = b x 100
b+d

= 2 x 100
2+30

= 6.25%

False negative % = c x 100
a+c

= 2 x 100
16+2

= 11%

In our study umbilical artery abnormal Doppler has significant correlation with adverse perinatal outcome with the sensitivity of 89%, specificity of 94%, Positive predictive value of 89%, Negative predictive value of 94%, false positivity rate of 6% and false negative value of 11% .

Trudinger et al investigated the effectiveness of the umbilical artery abnormal velocimetry for predicting adverse perinatal outcome. He

concluded even the S/D Ratio had sensitivity of 37%, specificity of 92%, and he also said that umbilical artery Doppler indices are sensitive to acidosis.

Nicolaids and associates in their study showed that AEDV had sensitivity of 90%, specificity 92%, PPV 53%, NPV 100% in predicting adverse perinatal outcome.

SUMMARY

SUMMARY

This study was undertaken in Government Rajaji Hospital, Madurai during the period from January 2005 to February 2006 with the aim of evaluating Doppler flow velocimetry of uterine and umbilical artery in the early detection of fetal hypoxia and its correlation with perinatal outcome.

50 patients with gestational hypertension and preeclampsia randomly selected from the antenatal ward and labor ward were recruited in this study. Majority of them belonged to the age group of 20-30 years (76%) and above 30 years comprised only 6%

primi gravidas and Multi gravidas were almost equally distributed (44 vs 56%). Anemia and oligohydroamnios were the common coexisting complication each occurred in 20% of the cases. In our study totally – 12% (6 cases) of cases had accidental haemorrhage.

Mild proteinuria was present in 20% of the cases. 26% of the cases had massive proteinuria. 80% of those with proteinuric hypertension had abnormal Doppler flow either in umbilical or uterine artery or both.

Liquor volume was decreased in 16% of the cases and in 4% severe oligohydroaminos were noted.

Out of the 50 cases of gestational hypertension and pre Eclampsia, 70% had abnormal Doppler. In the uterine artery Doppler flow velocimetry S/D Ratio was increased in 28.57% of the cases and early diastolic notch was present in 20% of the cases. All the mild PIH cases had normal Doppler flow finding.

Detection of abnormal uterine or umbilical artery doppler velocimetry occurs more frequently in patients with pre eclampsia than in those with gestational hypertension.

Presence of uterine artery notch during the III trimester is associated with a significantly increased rate of caesarean delivery for fetal distress and premature delivery. So the presence of notch is significantly a better predictor of adverse perinatal outcome than any other indices.

In the umbilical artery, high resistance flow was observed in 28.5% of the cases, AEDF in 14.2% cases. Reversal of flow was noted in 8.57% of cases (3cases). (2 of these cases developed Eclampsia antepartum (i.e.) 15% of the cases).All the 3 babies had severe IUGR with oligohydroaminos. All the cases which had AEDF and REDF in umbilical artery flow velocity waveforms also had Diastolic notch in uterine artery waveform.

On analysis of perinatal outcome with uterine artery when the flow was normal 93.93% of the babies had normal perinatal outcome, whereas if

the flow was abnormal 52.9% had abnormal outcome, showing that the uterine artery velocimetry has impact on perinatal outcome.

On analysis of perinatal outcome with umbilical artery Doppler velocimetry, Absent end diastolic flow has 40% perinatal morality rate and 60% perinatal morbidity, in the forms of low apgar at 5 mts, meconium aspiration, IUGR, Prematurity. With REDF the mortality rate is 100%. So it predicts ominous sign - impending IUD.

On analyzing the mode of delivery 14% delivered vaginally without interference, PGE_2 Gel induction was done for 12% of the cases, 8% of the cases delivered by outlet forceps. The overall caesarean section rate with abnormal Doppler was 24%.

Correlating the mode of delivery with uterine artery flow velocity waveforms, with High resistant flow $3/4^{th}$ of the cases ended up in vaginal delivery and $1/4^{th}$ of the cases ended in caesarean section. With early diastolic notch, the incidence of caesarean section was 42.85%.

Correlating the mode of delivery with umbilical artery Doppler velocimetry, with High resistance flow 80% had vaginal delivery. But with AEDF and REDF > 60% ended up with caesarean section.

Correlating birth weight with abnormal Doppler, it is found that majority of the babies with high resistance flow and early diastolic notch in uterine artery had birth weight < 2.5 kg. Out of which 16% had birth weight < 1.5 kg. With absent and reversal of diastolic flow in umbilical artery all the babies had birth weight < 2.3 kg. Out of which 40% had birth weight < 1.5 kg indicating severe IUGR is correlated with AEDF and REDF.

Evaluating the fetal salvage rate in uterine artery 57.14% salvage rate is observed with early diastolic notch whereas with AEDF of umbilical artery waveform, salvage rate is only 40% and all babies with REDF could not be salvaged.

Critical analysis of the perinatal mortality rate with uterine artery flow pattern shows 42.85% mortality rate. Similar analysis of the umbilical artery shows with AEDF shows 60% mortality rate and with REDF 100% mortality.

Doppler study of uterine artery shows significant correlation with perinatal outcome and has got sensitivity of 82%, specificity of 79%, positive predictive value of 53% and negative predictive value of 94%.

Umbilical artery Doppler flow pattern, also shows almost equal and good correlation with adverse perinatal outcome with a sensitivity of 89%, specificity 60%, positive predictive value 89% and negative predictive value almost reduced to 11%.

Also in this study it is observed that when both the uterine and umbilical artery flow velocity waveforms were abnormal, there is increased rate of IUGR, early termination of pregnancy, increased rate of caesarean section and higher rate of neonatal complications, correlating more with adverse perinatal outcome.

CONCLUSION

CONCLUSION

Doppler flow velocimetry is a very good tool for the early diagnosis and effective management of fetal hypoxia particularly associated with severe PIH and pre eclampsia cases with chronic uteroplacental insufficiency and causing IUGR.

Uterine and Umbilical artery Doppler flow velocimetry studies are very sensitive in predicting adverse perinatal outcome in hypertensive diseases complicating pregnancy with IUGR.

Doppler studies, detect intra uterine hypoxia earlier and help us for early induction and vaginal delivery thereby decreasing operative delivery and its maternal morbidity.

It is safe, non invasive technique, easy to perform, easy to interpret, and hence most valuable tool in the armamentarium of obstetricians and indispensable for the management of high risk pregnancy.

Because the changes in the uterine and umbilical circulations strongly correlate with the perinatal outcome, Doppler velocimetry is a primary tool for Feto maternal surveillance in hypertensive pregnancy.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. ADI Dastur. Indian Journal of Medical Ultrasound. Duplex Doppler Evaluation in Normal and High-risk pregnancy Vol No 9, Page no 39.
2. Ardini D.,Rizzo G., Bocudine et al (1990) – Functional assessment of uteroplacental and fetal circulations by means of colour Doppler. – J. of Ultrasound Med. – 9:
3. ARDUINI D. RIZZO G. ROMANINI C. The development of abnormal heart rate patterns after absent end diastolic velocity in umbilical artery. Analysis of risk factors AMJ. Obstetrics and Gynecology 1993 168; 43-50
4. Battaglia C., Artini PG., et al 1993 - Absent or reversed end diastolic flow in umbilical artery and severe IUGR – an ominous association – Acta Obstet. Gynaecol. Scan 72
5. Bhat AB, TankPd, Barmade KB, Damania KR – Abnormal Doppler flow uelocity in the growth Restricted fetus as a predictor for necrotising enterocolitis. Dept of obstetrics and Gynecology, Seth G.S. M. College parel, Mumbai 40012/India 2002.
6. Bhushan N lakhar, Shafeek A Ahamed - Doppler velocity of uterine and umblical artery during pregnancy Indian journal – Radiol Imaging 1999; 9:3:119-125.
7. BRAR H.S. PLATT L Reverse end diastolic flow waveforms in umbilical artery velouinetry in high risk pregnancy – An obvious finding with adverse prenatal outcome. Am.J. obstetrics and Gynecology 1988 159:559-61.
8. Brar HS. Relationship of systolic diastolic ratios from umbilical velocimetry to fetal heart rate. Am J Obstet Synecol 160:188.1989.

9. Brosens I: The physiological response of the vessels of the placental bed to normal pregnancy. J. Pathol Bacteriol 1967; 93:569-79.
10. Brosens IA. Morphological changes in the uteroplacental bed in pregnancy hypertension clin ob & Gy 1977;4:573-93.
11. Campells S. et al. New Doppler technique for assessing uteroplacental blood flow. Lancet 1983; I:676-7.
12. Campells S. Qualitative assessment of uteroplacental blood flow: Early screening test for high-risk pregnancies. Ob & Gy 1986:68:649-53.
13. Cohen-Overbeek T, The entenatal assessment of utero – placental and feto-placental blood flow using Doppler ultrasound. Ultrasound Med Biol 1985;2: 329-39.
14. Craigo S.D.,Beach M.L., Harvey Wilkes K.B., et al Ultrasound Predictors of neonatal outcome in IUGR – Am. J. perinatol 1996 : 13
15. Davies JA, Variability of continuous – wave Doppler flow velocity waveform indices from the umbilical artery. Obstet Gyncol 76:366,1990.
16. Ducey J., Schulman H., Farmakides G. et al – 1987 – A classification of hypertension in pregnancy based on Doppler velocimetry - Am. J. Obst. & Gynaecol. 157
17. Erskine RLA. Umbilical artery blood flow characteristics in normal and growth retarded fetuses. Br J Ob & Gy 1985;92:605.
18. FERNANDO ARIAS Intra Uterine growth restriction – Practical guide to high-risk pregnancy and delivery 2nd Edition P-301 to 319.
19. Fleischer A, et al. Uterine artery Doppler velocrimetry in pregnant women wih hypertension. AM J OBSTET GYNECOL. 1986; 154:806-103.
20. Fleischer A. et al. Umbilical artery velocity waveforms and intrauterine growth retardation Am J OBSTET GYNECOL. 1985;151:502.

21. Fleischer A., Schulman H., Farmakides G. et al – Uterine Artery Doppler primary in pregnant women with hypertension – Am. J. Obst. & Gynaecol.154
22. GAGNON R. VANDENHOT.M. Diagnostic imaging committee Executive council of the society of obstetrics and Gynecologists of Canada. The use of fetal Doppler in obstetrics J. Obstet Gynecol can 2003 Jul 25 (7) 601-14.
23. Griffin D. Fetal and uteroplacental blood flow. Clin obstet Ob & Gy 1983; 10:565.
24. Gud Murdsson S., Marsal K., (1988) Ultrasound Doppler evaluation of uteroplacental and fetoplacental circulation in preeclampsia – Arch. Gynaecol – Obstet. – 243
25. HACKETT G.A. CAMBELL S. GMSU. H., Doppler studies in growth retarted fetus and prediction of nconatal recrotising entertocoletis intra ventricular hemorahage & neonatal morbidity Br. Medical Journal 1987: 297:13-16.
26. Hanretty K.P., Whittle M.J., Doppler Uteroplacental waveform in pregnancy induced hypertensions Lancet Journal.
27. Haraldur M – Gudnasson sac Mundur – Gudmundsson - Preeclampsia – Abnormal uterine artery Doppler Related to Recurrance of symptoms during next pregnancy.10/1515/JPM/2004, 138.
28. H.Li.H. Gudnason, P. Olofisson, K. Dubiel, S. Gudmundsson - University of Lund, Dept. of Obst. and Gyn. Malmo U niversity, Hospital, Swedes. Increased uterine artery vascular impedence is related to adverse outcome of pregnancy but is present in only 1/3 of late third trimester preeclampsia women. Jan 2005.
29. Jame Iicht et al Doppler and ultrasound – Williams Obstetrics 21st Edition: Appleton & Large Stanford P – 743 and 1132.

30. Jouppila P. Blood velocity waveforms of the fetal aorta in normal hypertensive pregnancies. Ob & Gy 1986;67;856.
31. Karr K. et al. Intervillious blood flow in normal and complicated late pregnancy measured by means of an intravenous 133 Xe method. Acta Ob & Gy Scand 1980:59:7-10.
32. Lunell No. et al Uteroplacental blood flow in preeclampsia Measurements with indimum 113 and computer linked gamma camera. Clin Exp Hypertension (A) 1992;105:117.
33. MADAZLI R. ULUDAG S. OCAK V. Doppler assessment of umbilical artery, thoracic aorta and middle cerebral artery in the management of pregnancies with growth, restriction. Acta obslet Gynecology scand 2001, 80: (702-7)
34. MARSHEED M. JIROUS J. AHMED MA. VISWANATHAN DI., Middle cerebral artery to umbilical artery resistive indck ratio in the prediction of neonatal outcome. Int J. Gynaeco: obset 2000.71: 119-25.
35. Maulik D Comparative efficacy of the umbilical arterial Doppler indices for predicting adverse perinatal outcome. Am. J. O&G 164;1434-1440-1991.
36. Mehalek KM. et al. Umbilical and uterine artery flow velocity wave forms. Effect of the sampling site on Doppler rations. J Ultrasound Med 8:171,1989.
37. NARENDRA MALHOTRA, JAIDEEPT MALHOTRA. SAKSHI MITTAL. IUGR: Ultrasonography and Doppler evaluation obstetrics & Gyneaclology today vol. VIII No:4 April 2003. (p 215-219)
38. NEILSON JP. ALFIREVIC. Doppler USG for fetal assessment in high risk pregnancy. Cochrane Library issue 4, 2001.
39. Nylund L. Uteroplacental: blood flow index in intrauterine growth retardation of fetal or maternal origin. Br J Obstet GB & GY 1983;90:16-20.

40. Papageoghiou AT7, Esrasmus FE, Cucle Hs, Nicolaides KH -. Assessment of risk for the development of preeclampsia by maternal characters and uterine artery Doppler BJOG – 2005 Jun 12 (6) 703-709.
41. Pearce JM: Uteroplacemtal and fetal blood flow. In: Whittle MJ (ed): Bailliere's Clinical Obstetrics and Gynaecology, Vol 1:1 Fetal Monitoring. London, Baillers Tindall, 1987,p 157.
42. PETER MC PARHAND, J. MACCOM PEARCE Recent advances in obstetrics and Gynecology – Vol 16 Doppler studies in pregnancy. P.44.
43. PREETGI DUBAY and PADMA CHATURVEDI. Doppler waveform analysis in high risk pregnancy. Asian J. obstetrics & Gyneaclology practice, vol 7, No.5. May 2003 (P23-26)
44. Pritchard JA. Hypertensive disorders in pregnancy In: Pritchard JA, MacDonald PTC, eds. Williams obstetric 17th ed. New York: Appleton – Century – Crofts. 1985:525-61.
45. RAJAN . R. Doppler in IUGR and management – ultrasound and colour Doppler in obstetrics. Gynecology and infertility – 2004 Edition.
46. Recheison B: The clinical significance of absent end diastolic velocity in the umbilical artery waveforms.Clinical Obstet Gvnecol 32:692. 1989.
47. RIZA MADAZLI. SEYLETTIN ULLIDAG AND VILDANOCAK Acta obstetrics and Gynecology scandrinaria, vol 80 Issue 8 P-702. August 2001.
48. Rochelson B., Schulman H., Farmakides G et al (1987) Significance of absent end diastolic velocity in umbilical artery velocity waveforms - Am. J. Obst. & Gynaecol.156

49. Stuart B, et al. Fetal blood velocity waveforms in normal pregnancy. Br. J Obstet Bynaecol 1980;87:780.
50. SUPRIYA SESHADRO. KAMINI RAO. Fetal Doppler. Asian J. obstetrics & Gyneaclology practice vol.7 No: 7, August 2003 (P 17-22)
51. TRUDINGER BJ, Cook.CM. Doppler umbilical and uterine artery flow wave forms in severe pregnancy induced hypertension Br.J. obstetrics and Gynecology 1990: Feb; 97 (2) : 142-8.
52. TRUDINGER 13.J.Cook.CM. GILES W.B. et al umbilical artery velocity waveform and subsequent neonatal outcome Br.J. obstetrics and Gynecology 1991:98 378-384.
53. Trudinger BJ. Uteroplacental blood flow velocity – time waveforms in normal and complicated pregnancy. Br J OBSTET Gynaecol 1985;92:39-5.
54. Trudinget BJ. et al. A comparison of fetal heart rate monitoring and umbilical artery waveforms in the recognition of fetal compromise Br J OBSTET Gyneacol 1986;93:171.
55. Tyrrell S., Oboid A.H., Lilford R.J. (1989) Umblical artery Doppler velocimetry as a predictor of fetal hypoxia and acidosis at birth - Obstet. & Gynaecol.-74
56. T. Frusca, MD, M. Soregaroli C. Platto, MD, L. Enterri, MD, A. Lojaaiono, MD and A. Valiamonico, MD, Uterine A. Velocimetry in patients with gestational hypertension from the department of obstetrics and gynaecology, university of Bresicia, Italy.
57. Vergani P. Roncaglia N, Locatelli A, Crippa L, Ghidni Antenatal prediction of neonatal outcome in fetal growth restriction with absent end diastolic flow in umbilical artery AmJ – Obstet Gynecol – 2005 – September 11- 121-38

58. Vergori P., Anderotti C., Ron CagliaNetal - Doppler predictors of adverse neonatal outcome in growth restricted fetuses at 34 weeks gestation or beyond.- Am. J. Obstet. & Gynaecol.
59. Vieyres.P., The Resistance Index in the umbilical arteries: Journal of Ultrasound in Medicine December 1991.
60. WKADUNIROFF.J.W., WHANAGARD W.D. DEGANIS Cerebral and umbilical arterial blood flow velocity waveforms in normal growth retarted fetuses obstetrics and Gynaecology 1987, 69:705-709.

PROFORMA

PROFORMA

TOPIC: DOPPLER STUDY IN GESTATIONAL HYPERTENSION & PRE ECLAMPSIA

S.No: Unit:

NAME: I.P.No:

OCCUPATION:

INCOME:

SOCIO ECONOMIC STATUS: CLASS;

RESIDENCE:

URBAN RURAL

COMPLAINTS:

- Amenorrhoea LMP:
  EDD
- Swelling feet/Epigastric pain
- Decreased urine output/blurring of vision
- Other Imminent symptoms
- Pain abdomen

MENSTRUAL HISTORY Menarche: Regular /Irreg.

LMP: EDD:

MARITAL HISTORY

OBSTETRIC HISTORY

LCB

PREVIOUS OBSTETRIC PERFORMANCE

1. History of IUD
2. History of IUGR
3. H/o.PIH in the previous pregnancy

OTHER COMPLICATIONS ASSOCIATED

Anaemia

Heart disease

CLINICAL EXAMINATION

Ht :
Wt:
Anaemia
Edema Legs
PR:
CVS:
BP:
RS:

ABDOMINAL EXAMINATION

Symphysiofundal Ht:
FH
LIQUOR CLINICALLY

PV

Investigations
Urine : Alb:
Sug:
Deposits:
Blood :
Hb %:
Gr/ Typing:
Urea:
Sugar:
Serum Creatine:
LFT
Fundus
CTG

ULTRASONOGRAM

BPD

FL:
HC:
AC:
LIQUOR:
PLACENTA/RP CLOTS

DOPPLER STUDY

UMBILICAL ARTERY:

UTERINE ARTERY:

TREATMENT

DATE OF DELIVERY

MODE OF DELIVERY VAGINAL- SPONTANEOUS / INDUCED

LSCS:

INTRAPARTUM COMPLICATIONS:

Abruptio Placenta:

Eclampsia:

Hellp Syndrome

Others:

Colour of Liqour:

NEONATAL OUTCOME:

LIVE BORN: BORN ALIVE & DEAD STILL BORN

APGAR-1'
5'

Sex of baby M/F
Birth wt in kg

Congenital malformation Yes No

Neonatal morbidity Yes No

Preterm Baby

Small for GA

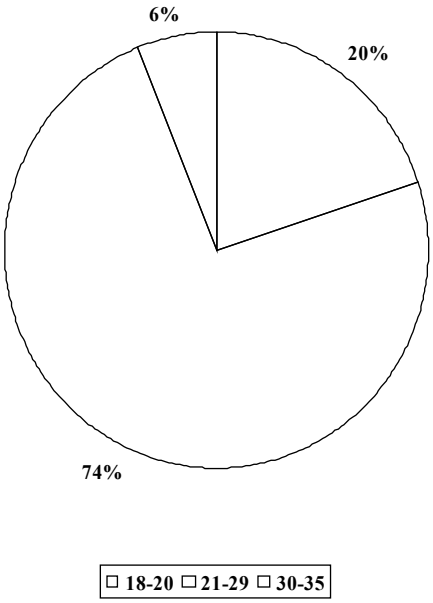
Admission to NICU: Yes No

Reason:

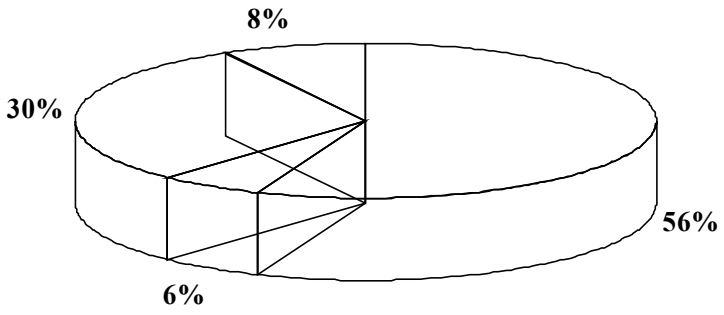
Duration of admission:

Condition at discharge:

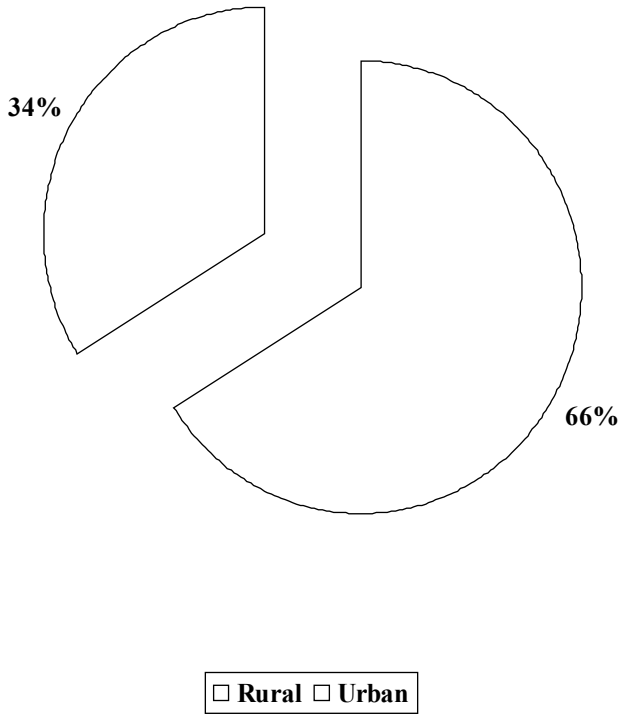
Age Distribution



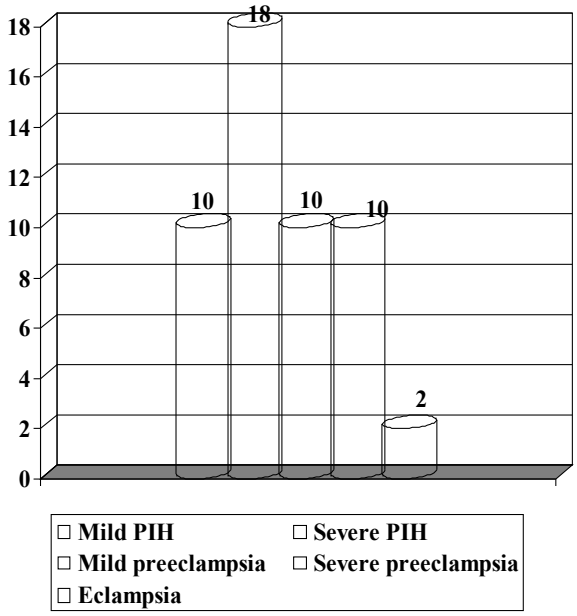
Gravidity and PIH



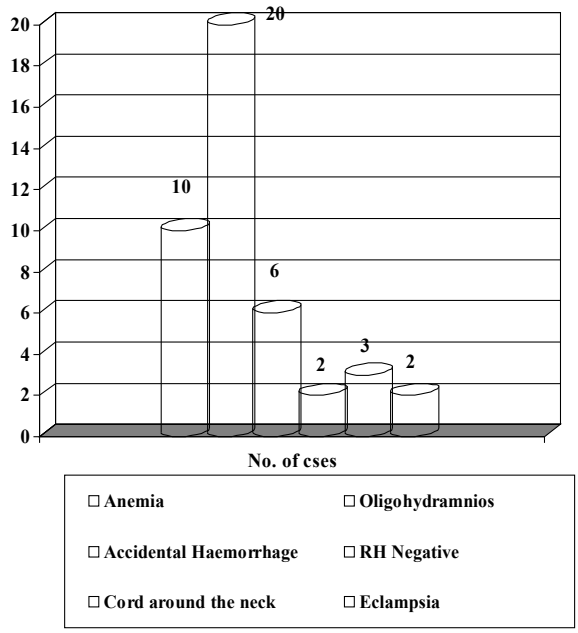
Relationship between living area and PIH



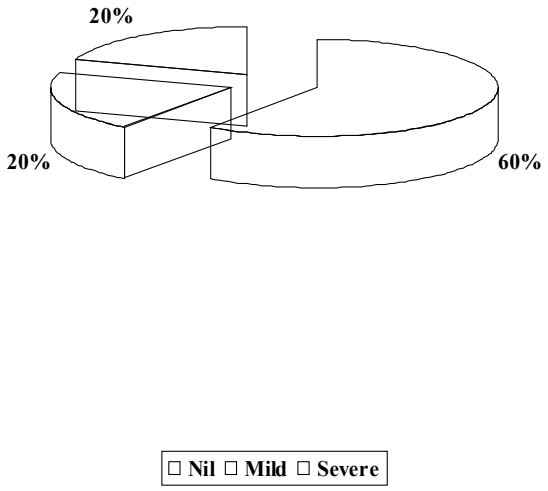
Classification of PIH



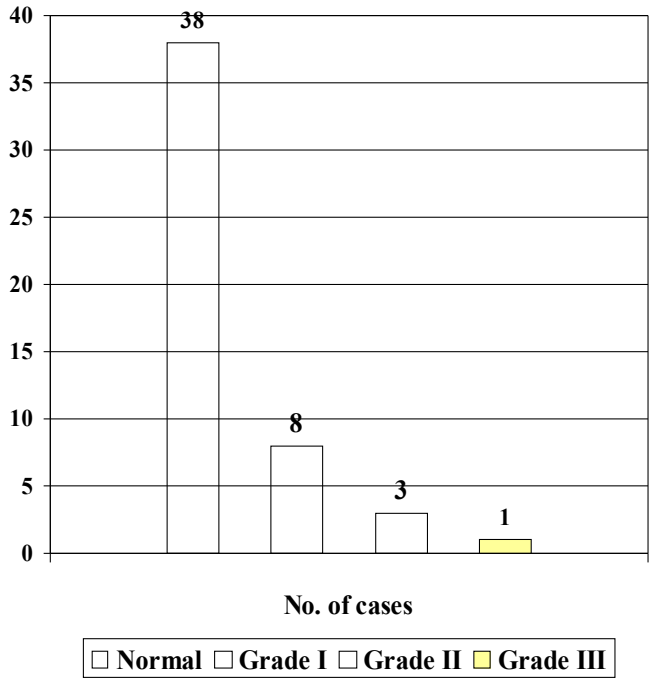
Other Complications Coexisting



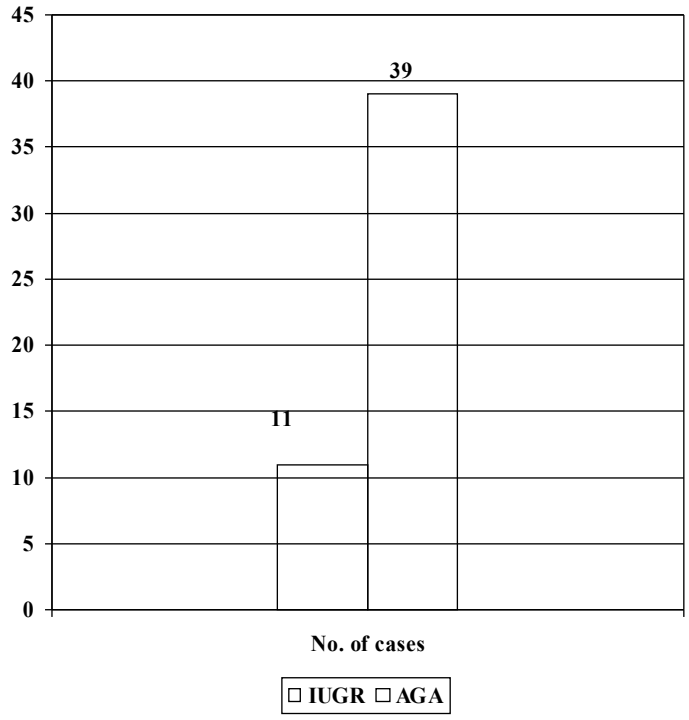
Proteinuria and PIH



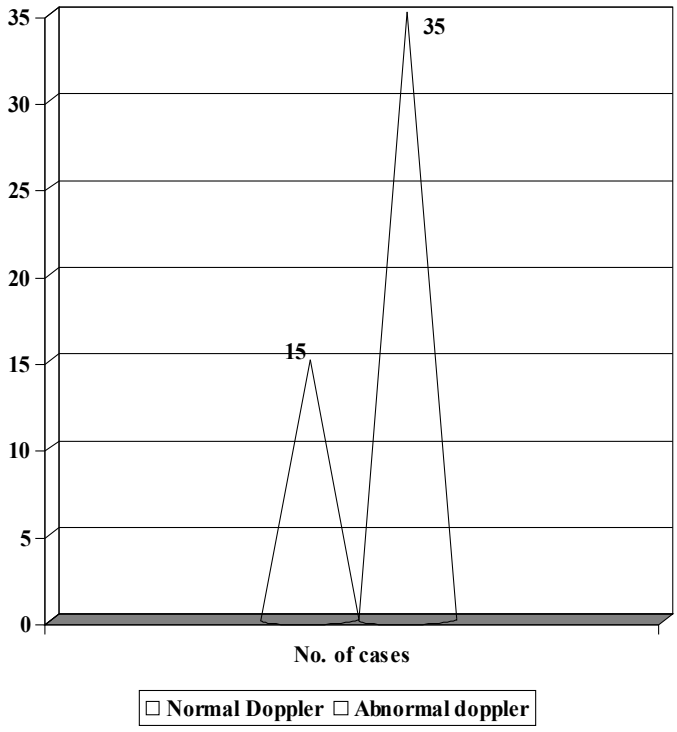
Fundus


40
35
30
25
20
15
10
5
0
38
8
3
1
No. of cases
Normal
Grade I
Grade II
Grade III

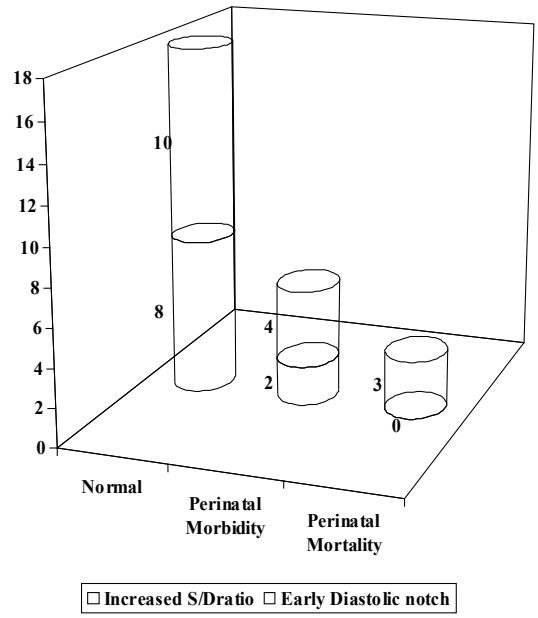
IUGR by USG EFW



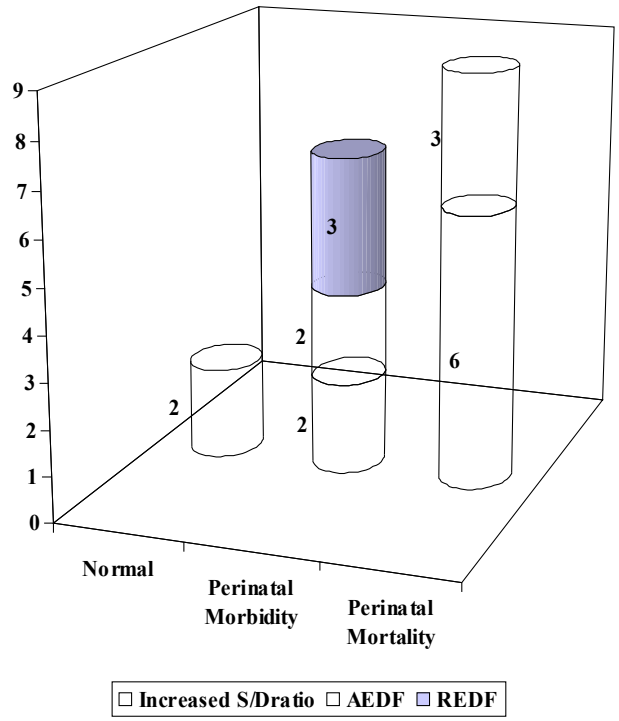
Relationship between Doppler study of umbilical artery and uterine PIH



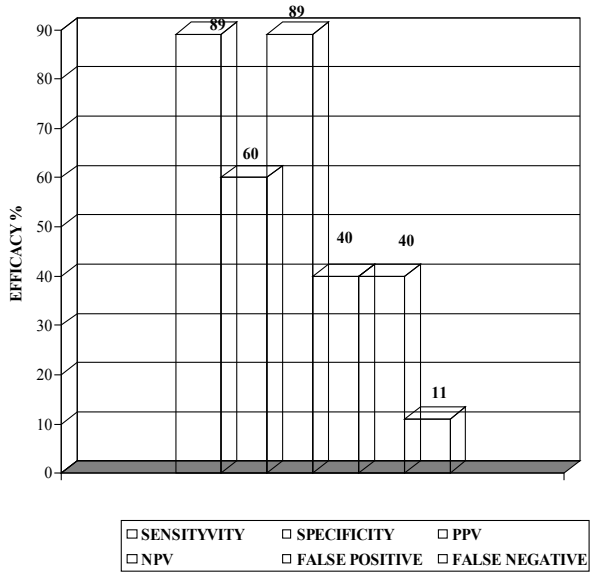
Uterine artery doppler and perinatal outcome



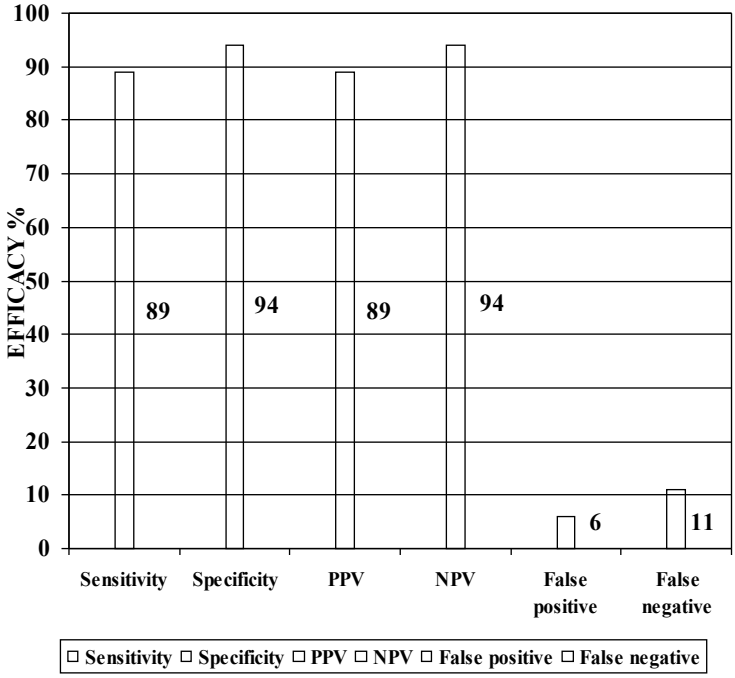
Umbilical artery doppler and perinatal outcome



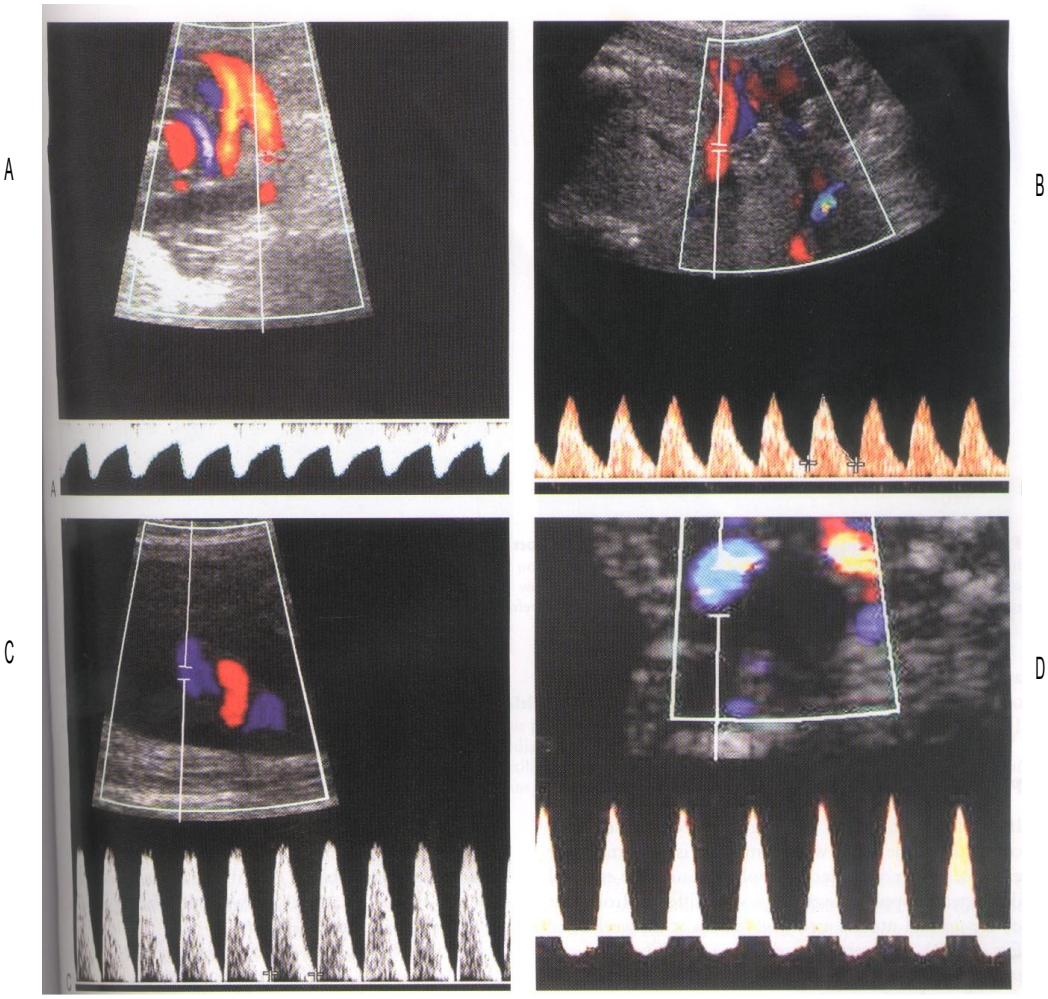
Umbilical Artery and Perinatal Outcome
Efficacy Parameters



Uterine Artery and Perinatal Outcome
Efficacy Parameters



UMBILICAL ARTERY DOPPLER WAVEFORMS



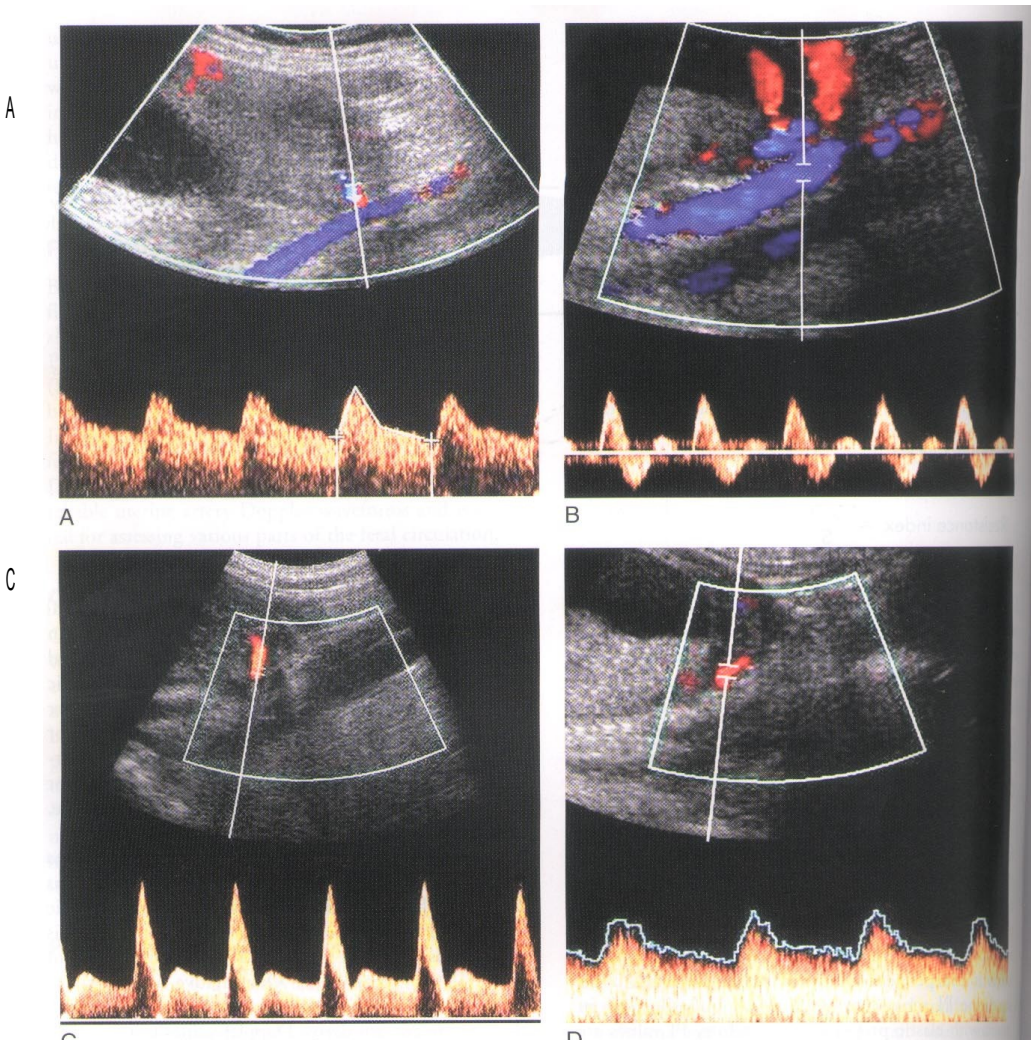
A - Normal waveforms at 28 weeks

B - Reduced Diastolic flow

C - Absent end diastolic flow

D - Reversed end diastolic flow

UTERINE ARTERY DOPPLER WAVEFORMS



A - Pulsed Doppler GATE - Uterine artery above external iliac artery

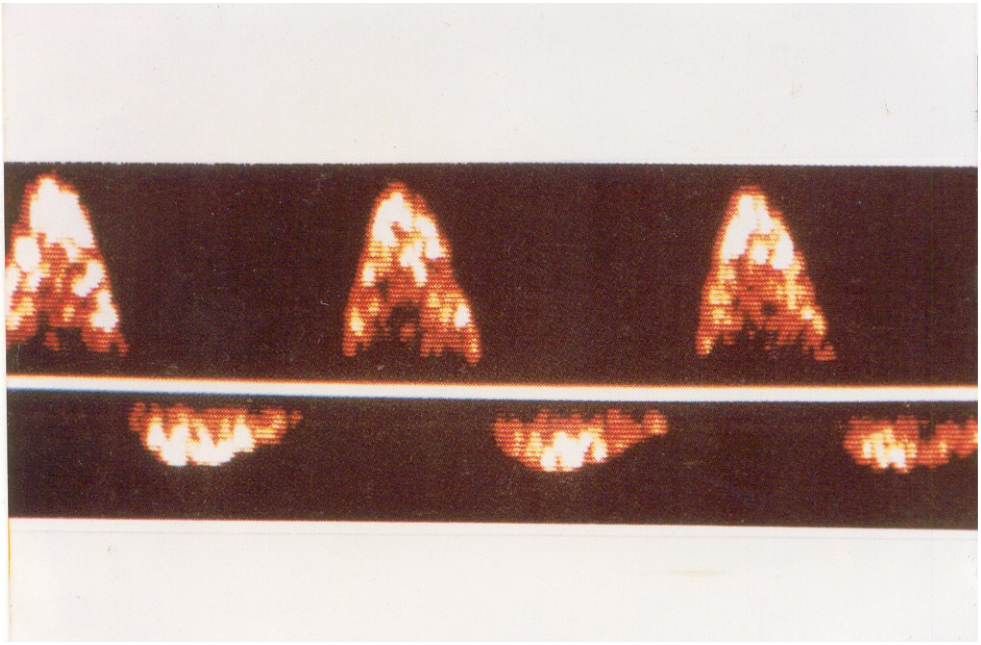
B - Corresponding external iliac artery waveform

C - Waveform with increased pulse

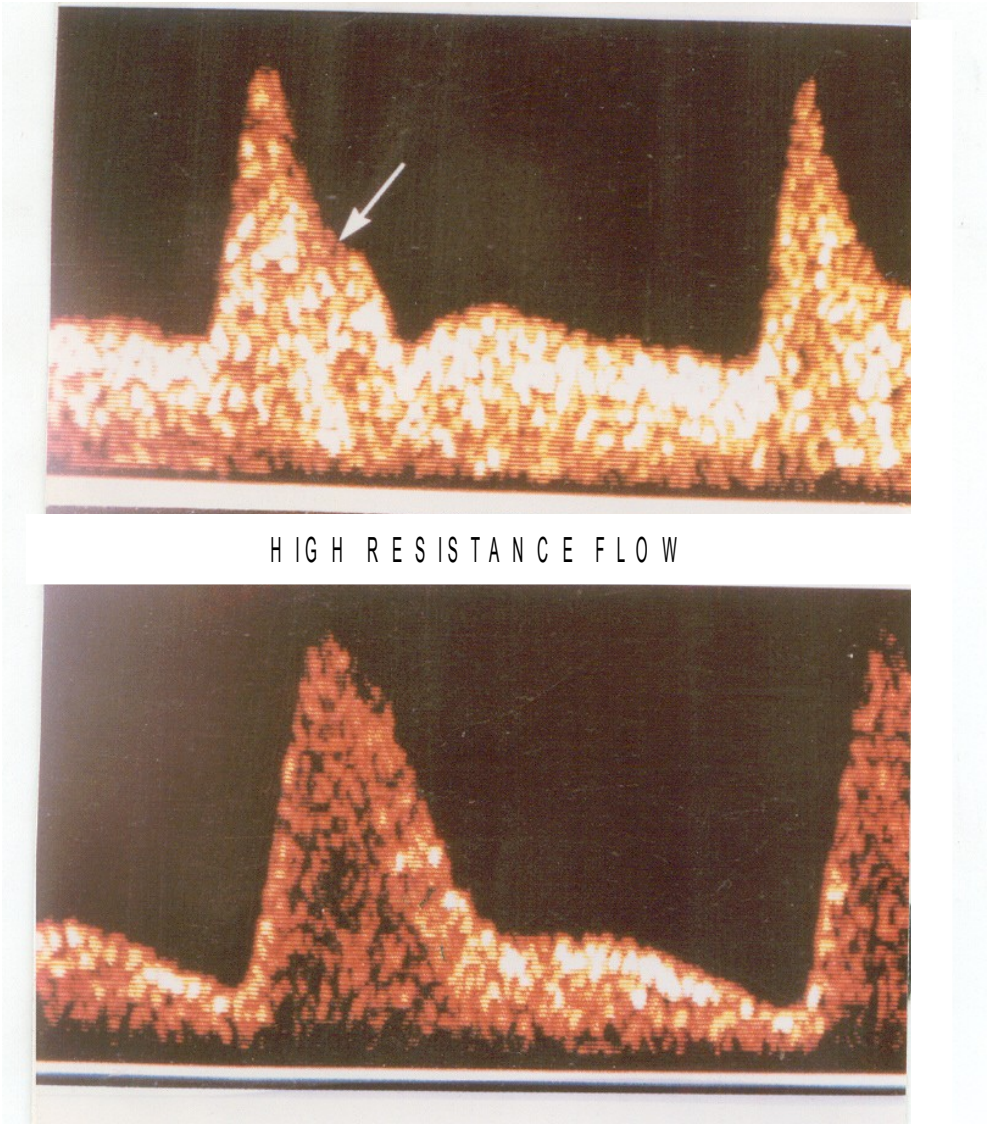
D - Alternative online high 'Q' waves

UMBILICAL ARTERY WAVEFORM

REDF (Reversed End Diastolic Flow)



UTERINE ARTERY WAVEFORM - Early Diastolic Notch



HIGH RESISTANCE FLOW

U M B IL IC A L A R T E R Y

(A b s e n t e n d d ia s to lic flo w)